

University of California, Berkeley

PUBPOL 290: Energy Regulation and Public Policy

Spring 2021

Practicum

A Methodology for Geographically-Targeted Building Electrification for Environmental and Social Justice Communities in California

Prioritizing vulnerable communities in the transition away from natural gas

Isabelle Hens and Emily Lamon

Steven Weissman

Building Decarbonization Coalition

Table of Contents

Introduction	4
What is building electrification and why is it important?	4
Why do we need to focus on environmental and social justice communities?	5
Why a geographically-targeted approach?	7
Existing Energy Programs for Low-Income Households	7
Existing Decarbonization and Electrification Frameworks	9
California Energy Commission - The Challenge of Retail Gas in California's Low-Carbon Future	9
The Greenlining Institute - Equitable Building Electrification	11
RMI - eLab Accelerator 2020	11
Common Spark Consulting - The Flipside Report	12
Proposed Geographical Electrification Framework	13
Key Considerations	14
Methodology	15
Input Parameters	16
Analysis of San Francisco Bay Area and Adjacent Central Valley	19
Analysis of Los Angeles Area	26
Proposed Policies in Support of the Geographical Framework	33
Avoid Expansion of the Gas System	33
Rent Protections for Tenants	34
Provide Sufficient Funding for Building Owners	34
Create Synergies Among Incentive Programs	35
Support All-Electric Equipment and Provide Technical Assistance	35
Redefine the Obligation to Serve	35
Suggestions for Future Work	36
Conclusion	37
Acknowledgements	38
References	38

List of Abbreviations

AB 1550	California Assembly Bill 1550
AEA	Association of Energy Affordability
AHSC	Affordable Housing and Sustainable Communities
CARE	California Alternate Rates for Energy
CCI	California Climate Investments
CDLAC	California Debt Limit Allocation Committee
CEC	California Energy Commission
CPUC	California Public Utilities Commission
CSE	Center for Sustainable Energy
CSGT	Community Solar Green Tariff
CSI	California Solar Initiative
DAC-GT	Disadvantaged Communities – Green Tariff
DAC-SASH	Disadvantaged Communities – Single-family Solar Homes
EPA	Environmental Protection Agency
ESAP	Energy Savings Assistance Program
ESJ	Environmental and social justice
HCD	California Department of Housing and Community Development
HUD	United States Department of Housing and Urban Development
LIFT	Clean Energy Low-Income Family and Tenants
LIHEAP	Low-Income Home Energy Assistance Program
LIHTC	Low-Income Housing Tax Credit
LIWP	Low-Income Weatherization Program
MASH	The Multifamily Affordable Solar Housing
MCE	Marin Clean Energy
NOAH	Naturally Occurring Affordable Housing
NPA	Non-pipeline alternative
NRDC	Natural Resources Defense Council
OEHHA	Office of Environmental Health Hazard Assessment
PG&E	Pacific Gas and Electric

PM	Particulate matter
PSPS	Public safety power shutoff
RNG	Renewable natural gas
SASH	Single-family Solar Affordable Solar Housing
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SoCalGas	Southern California Gas Company
SOMAH	Solar on Multifamily Affordable Housing
TCAC	Tax Credit Allocation Committee
TCC	Transformative Climate Communities
USDA	United States Department of Agriculture

Introduction

This report proposes a geographical decision framework for the transition of buildings away from on-site natural gas combustion to all-electric infrastructure. Geographical electrification allows for a targeted retirement of the gas distribution infrastructure, i.e. decommissioning entire communities or distribution pipelines rather than individual households (Figure 1).¹ If a geographical approach is implemented in a cost-effective and equitable way, it can reduce utility expenditures on operations, maintenance, and replacement of aging infrastructure^{2,3} while also alleviating the financial and pollution burdens of environmental and social justice (ESJ) communities.⁴

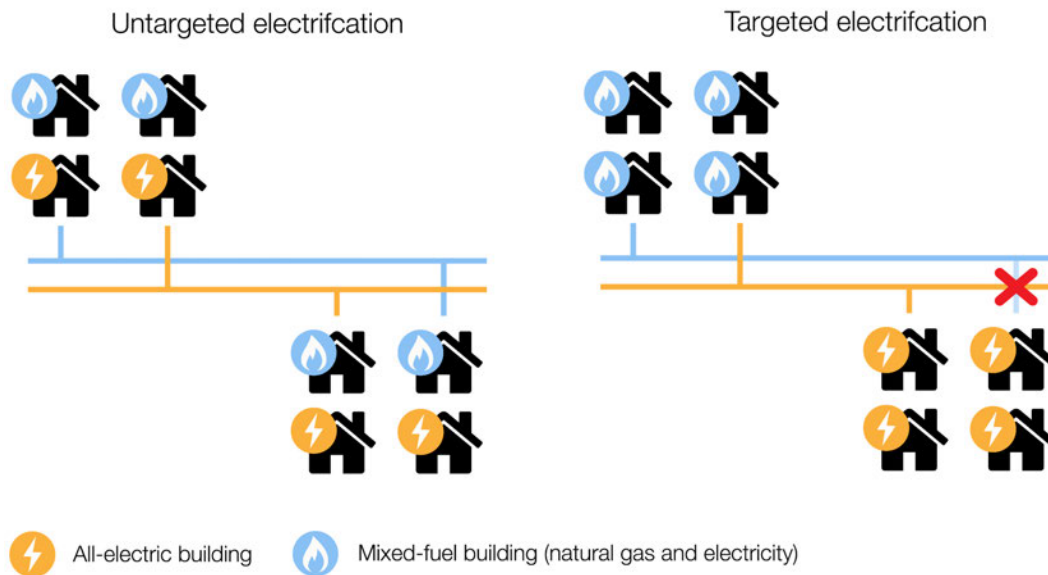


Figure 1: Untargeted vs targeted electrification (figure based on California Energy Commission, 2020).⁵

What is building electrification and why is it important?

California's building stock is responsible for 25% of the state's greenhouse gas emissions.⁶ In 2018, California established a goal for carbon neutrality by 2045.⁷ Because California's electricity supply is among the cleanest in the country, decarbonization experts agree that building electrification is one of the most viable and cost-effective strategies to achieve carbon neutrality.⁸ So far, 42 cities in California have adopted

¹ Common Spark Consulting (2021). *The Flipside Report: A White Paper on Targeted Geographic Electrification in California's Gas Transition*.

² California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

³ Sierra Club (2019). *Building Electrification Action Plan for Climate Leaders*.

⁴ Sierra Club (2019). *Building Electrification Action Plan for Climate Leaders*.

⁵ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

⁶ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

⁷ World Green Building Council (n.d.). *Climate champion California joins the Net Zero Carbon Buildings Commitment*.

⁸ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

building codes to limit natural gas use in new construction projects, including cities such as Berkeley and San Jose.⁹ However, these regulations do not address existing California residential properties, nearly 80% of which are currently connected to the natural gas system.¹⁰

In order to meet California's carbon reduction goals, the state will need to make significant investment in retrofitting existing housing stock. Many construction challenges are present in electrification retrofits, including the availability of all-electric equipment, construction and installation expertise, and the existing electrical infrastructure capacity in many California homes.¹¹ Electrical breaker panels often do not have sufficient amperage to run an entire home on electricity. In addition, homes built before 1978, when Title 24 came into effect, have a lower chance of being able to support the 240 volt electrical requirements of large appliances such as ovens, stovetops, water heaters, and clothes dryers.¹² When a natural gas appliance breaks down and the owner needs to replace it, these electrical infrastructure upgrades make an electric appliance replacement much less financially attractive than a natural gas appliance replacement. When an appliance breaks down, it is often time sensitive to find a replacement and to get the system operating again as normal. It is not always feasible to wait for electrical infrastructure upgrades to be carried out before getting a new appliance. The construction challenges associated with electrification retrofits require the state to plan ahead. Not replacing gas equipment upon failure slows down the transition to electricity and might cause expensive early retirement in the future when climate goal deadlines are much closer.¹³

Why do we need to focus on environmental and social justice communities?

The California Public Utilities Commission defines environmental and social justice (ESJ) communities as “communities where residents are: predominantly people of color or living on low incomes; underrepresented in the policy setting or decision-making process; subject to disproportionate impact from one or more environmental hazards; and likely to experience disparate implementation of environmental regulations and socioeconomic investments”¹⁴. According to The Greenlining Institute, “these communities, often largely composed of renters, have largely been left out of California's push toward clean energy solutions”.¹⁵ Low-income ESJ communities might be exposed to financial risks caused by the costs of building upgrades and increased electricity rates in market rate affordable housing. In addition, ESJ communities are

⁹ Matt Gough (2021). *California's Cities Lead the Way to a Gas-Free Future*. Sierra Club.

¹⁰ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

¹¹ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

¹² NRDC, Olivia Ashmoore (2020). *Policy Pathways to Zero-Emissions Buildings*.

¹³ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

¹⁴ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

¹⁵ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

disproportionately exposed to public health risks due to higher pollution burdens, caused by historic decisions around locating shared infrastructure such as highways and power plants.

Environmental justice and community advocates have warned that landlords may pass on the cost of building upgrades to tenants, therefore making housing less affordable and furthering gentrification in communities. There is currently no regulatory or statutory protection to prevent building owners from evicting current tenants in order to rent to more affluent tenants.¹⁶ The split incentive problem, in which building owners pay for improvements but renters get the benefit of reduced utility bills, is exacerbated by California's housing crisis, where demand surpasses supply.¹⁷ In addition, the UCLA Institute of the Environment and Sustainability found that "whole house electrification programs are likely to exacerbate daily peak electricity loads and increase total household expenditures on energy", and states that "low-income residents of disadvantaged communities, who have the least flexible work schedules, the least access to high-efficiency appliances and energy management systems, and inhabit the most poorly insulated housing stock, will be most adversely affected by these changes".¹⁸

According to The Greenlining Institute, in 2019, 45% of Californians were renters and about 25% of Californians were renters living on low to extremely low incomes.¹⁹ Renters and low-income households might experience additional financial burdens due to limited agency over when and how their households transition to electricity.²⁰ If electrification drives down demand for natural gas, ESJ communities could become some of the last remaining customers served by the gas utility and could end up bearing the burden of large utility bills to cover the high fixed costs of the natural gas infrastructure.²¹ Equitable electrification policies must be put into place to protect low-income households from high and unpredictable utility bills as infrastructure transitions from natural gas to electricity.

A final factor to take into account when designing equitable electrification policies is the potential impact on public health, including outdoor and indoor air pollution. Burning natural gas indoors in an equipment closet or on a stovetop releases nitrogen oxides and particulates, which can have long-term health effects (especially for children and the elderly) such as triggering asthma attacks, decreasing overall lung function, and increasing chances of serious respiratory illness.²²

¹⁶ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

¹⁷ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

¹⁸ Eric Daniel Fournier (2020). *Implications of the timing of residential natural gas use for appliance electrification efforts*. Environmental Research Letters.

¹⁹ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

²⁰ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

²¹ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

²² The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

According to the Natural Resources Defense Council (NRDC), “gas appliances in rental housing are older than appliances in owned housing and many are far older than their predicted life expectancy”.²³ For example, half of space heating appliances in rental housing are 20 years old or older, while we assume a usable life of 15-20 years.²⁴ Heat pumps have advantages in terms of comfort, safety, and health, so buildings with old gas equipment are good targets for electrification.²⁵ The California Public Utilities Commission (CPUC) developed an Environmental and Social Justice Action Plan in 2019, which lists among its goals to improve local air quality and public health for ESJ communities.²⁶ Prioritizing ESJ communities for electrification could have a positive impact on community health, as well as indoor and outdoor air pollution.

Why a geographically-targeted approach?

A geographically-targeted approach addresses exactly those communities who are most vulnerable to financial risks and pollution. In addition, targeted electrification has well established cost benefits. For an example targeted strategy, the California Energy Commission projects a reduction in gas system costs by \$4 billion annually in 2050 and by \$25 billion cumulatively in net-present value terms.²⁷ Geographical decommissioning and subsequent electrification reduces operation and maintenance costs of existing gas infrastructure and reduces investments in new and replacement infrastructure that will result in stranded assets.

Existing Energy Programs for Low-Income Households

There are many programs that address energy efficiency and building upgrades through financial incentives for low-income households and affordable housing developments. These programs are critical in providing financial support for vulnerable communities to deploy energy efficiency upgrades and to transition from natural gas to electricity. Below is a non-exhaustive overview of programs in California, which illustrates the plethora of programs at different levels with similar goals.

The **Low-Income Weatherization Program (LIWP)** is “the state’s first energy efficiency program that includes electrification designed specifically for Californians with low-incomes living in disadvantaged communities”.²⁸ It delivers greenhouse gas emission reductions and health, safety, and comfort upgrades.²⁹

The **California Solar Initiative (CSI)** was closed on December 31, 2016 because California did not deem it necessary anymore to provide direct incentives because a drop of equipment prices had transformed the

²³ NRDC, Olivia Ashmoore (2020). *Policy Pathways to Zero-Emissions Buildings*.

²⁴ NRDC, Olivia Ashmoore (2020). *Policy Pathways to Zero-Emissions Buildings*.

²⁵ AEA, Nick Dirr & Sheetal Chitnis (2020). *Multifamily Clean Heating Pilot: Summary of Project-level Analysis and Findings*.

²⁶ CPUC (2019). *Environmental and Social Justice Action Plan*.

²⁷ California Energy Commission (2020). *The Challenge of Retail Gas in California’s Low-Carbon Future*.

²⁸ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

²⁹ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

solar market.³⁰ However, CSI subprograms continue to provide incentives to low-income customers to install solar PV systems and to all utility customers to install solar water heating systems. The California Solar Initiative, along with the California Energy Commission's New Solar Homes Partnership (NSHP) and various solar programs offered through publicly owned utilities are part of Go Solar California.³¹ The CSI subprograms consist of several components which are grouped into two funding streams, depending on whether they use solar PV to reduce electricity consumption from the grid or solar thermal to reduce natural gas consumption.³²

PV solar programs include the following. The Single-family Solar Affordable Solar Housing (SASH) Program provides solar incentives to single-family low-income housing (administered through a statewide Program Manager, GRID Alternatives). The Multifamily Affordable Solar Housing (MASH) Program provides solar incentives to multifamily low-income housing (administered by Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and the Center for Sustainable Energy (CSE), in San Diego Gas and Electric's (SDG&E) service territory). The Disadvantaged Communities – Single-family Solar Homes (DAC-SASH) Program offers incentives for solar installations on owner-occupied, single-family homes. Other programs within this category are the Solar on Multifamily Affordable Housing (SOMAH) Program, the Disadvantaged Communities – Green Tariff (DAC-GT) Program, and the Community Solar Green Tariff (CSGT) Program. The thermal program for low-income households is called the CSI-Thermal Low-Income Program and provides incentives for solar thermal technologies to multifamily and single-family residential customers in PG&E, Southern California Gas Company (SoCalGas), and SDG&E service territories.

The **Energy Savings Assistance Program (ESAP)** provides “no-cost energy efficiency services and no-cost direct installation energy efficiency measures to income-eligible households via ratepayer funding”.³³

The **Low-Income Home Energy Assistance Program (LIHEAP)** is “a federally funded program that provides assistance to eligible low-income households with the goal of managing and meeting their energy costs and immediate home heating and/or cooling needs”.³⁴

The **Clean Energy Low-Income Family and Tenants (LIFT) Pilot Program** by Marin Clean Energy (MCE) combines health, habitability, and energy upgrades. In combination with MCE's existing Multifamily Energy Savings program, property owners can have up to 80 percent of the total project costs covered through the combined rebates.

³⁰ CPUC (n.d.). *California Solar Initiative*. <https://www.cpuc.ca.gov/general.aspx?id=6043>

³¹ CPUC (n.d.). *California Solar Initiative*. <https://www.cpuc.ca.gov/general.aspx?id=6043>

³² CPUC (n.d.). *California Solar Initiative*. <https://www.cpuc.ca.gov/general.aspx?id=6043>

³³ Southern California Gas Company (2019). *Energy Savings Assistance (ESA) Program: Impact Evaluation Program Years 2015-2017*.

³⁴ California Department of Community Services & Developments (n.d.). *Programs*. <https://csd.ca.gov/programs/>

The **California Alternate Rates for Energy (CARE) Program** provides low-income utility customers with a 30-35% discount on their electricity bill and a 20% discount on their natural gas bill. The program is available for customers of PG&E, SCE, SDG&E, SoCalGas, and other smaller utility companies.³⁵ According to Common Spark Consulting, bill protection programs like CARE should be expanded to address near-term rate impacts, and should increase the discount on electric rates over time to better support fully-electrified households, and should increase the discount on gas rates over time to protect customers unable to transition to electricity early.³⁶

According to The Greenlining Institute, many of these programs receive limited funding and the lack of program alignment creates a confusing landscape.³⁷ For example, LIWP has no guaranteed funding from the Greenhouse Gas Reduction Fund from year to year. In addition, LIWP is not coordinated with the utility-administered ESAP, which makes it almost impossible to combine both sources of funding on a single project.³⁸ The disconnect between energy and health programs that treat homes is a missed opportunity, as homes that need energy upgrades often also have other problems that need to be resolved before they can be treated. A referral loop among programs would assist owners in managing complex project timelines and requirements.³⁹

Existing Decarbonization and Electrification Frameworks

A number of organizations have put forward frameworks to support ESJ communities through the transition from natural gas infrastructure to electrified systems, including the Energy Research and Development Division of the California Energy Commission (CEC), The Greenlining Institute, RMI, and Common Spark Consulting. These frameworks provide crucial context to this report, as they illustrate the broad range of considerations when designing electrification policies with a focus on equity. While this report focuses on a few sub-strategies and guidelines of these frameworks, all considerations in these frameworks should be incorporated into equitable policy design.

California Energy Commission - The Challenge of Retail Gas in California's Low-Carbon Future

In *The Challenge of Retail Gas in California's Low-Carbon Future*, the CEC evaluated two scenarios that achieve an 80% reduction in California's greenhouse gas emissions by 2050 from 1990 levels: a high building

³⁵ CPUC (n.d.). *CARE/FERA Programs*. <https://www.cpuc.ca.gov/lowincomerates/>

³⁶ Common Spark Consulting (2021). *The Flipside Report: A White Paper on Targeted Geographic Electrification in California's Gas Transition*.

³⁷ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

³⁸ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

³⁹ The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

electrification scenario and a no building electrification scenario. In their study, they focus on three areas: technology options to decarbonize the natural gas system, implications for natural gas customers, and outdoor air quality and public health.⁴⁰ While the first area is out of the scope of this paper, we will also discuss the implications of electrification on natural gas customers (specifically low-income communities) and outdoor air quality and public health (specifically for areas vulnerable to public health risks). The CEC concluded that “building electrification is likely to be a lower-cost, lower-risk long-term strategy compared to renewable natural gas” and that “electrification across all sectors, including in buildings, leads to significant improvements in outdoor air quality and public health”.⁴¹

Based on their evaluation of the two scenarios, the CEC developed a set of eight strategies, divided into gas transition mechanisms and cost allocation mechanisms, which are laid out below. This paper will expand on strategies three and four because they are closely related to considerations of how we manage the transition from natural gas to electricity and which communities should transition first.

Gas transition mechanisms:

- 1) Reduce barriers to electrification. Current barriers include difficulty receiving permits and lack of experience installing heat pumps among contractors. Strategies to address these barriers include market transformation initiatives to lower costs and initiatives to enable low-income homeowners and renters to adopt electric equipment.
- 2) Avoid gas system expansion. By building communities without gas, we prevent adding additional obligations that will increase the cost of gas service for remaining customers.
- 3) Shut down uneconomic gas infrastructure to serve building loads. Targeted retirement of the gas distribution system saves costs in operations, maintenance, and replacement of aging infrastructure. It is difficult to identify geographies that are ripe for retirement and to successfully target electrification efforts.
- 4) Reduce costs of the existing gas system while ensuring safety and reliability. This can be achieved with geographically targeted electrification and gas system retirement. Derating of infrastructure (operating segments at lower pressures) can save costs in operation, maintenance, and reinvestment.

Cost allocation mechanisms:

- 5) Accelerated depreciation to recover investments in a shorter period of time. This can be justified because depreciation schedules should reflect the useful life of an asset, which is shortened as utilization decreases. The advantage is that this strategy reduces the remaining costs of the gas

⁴⁰ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

⁴¹ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

system by recovering investments sooner than the traditional useful lifetime. A disadvantage is that it increases near-time gas rates and gas utility revenue collection. Therefore, it needs to be combined with reduction in gas system expenditures and a long-term gas transition plan.

- 6) Change cost allocation. Increasing rates for remaining gas customers might make gas uncompetitive.
- 7) Recover gas system costs on the bills of electric ratepayers. This can be justified because the gas system was built for a stable long-term customer base. Customers that switch to all electric do no longer contribute to the system that was built on their behalf. Potential strategies are an exit fee or a competitive transition charge that is applied to the bills of all electricity customers. While this strategy promotes equity, it might discourage electrification, especially in the case of a lump sum exit fee.
- 8) Get additional funds from outside the gas system. Funding sources can be cap-and-trade revenues, state general funds, or decreased returns for utility shareholders.

The Greenlining Institute - Equitable Building Electrification

The Greenlining Institute developed a five-step framework for equitable building electrification focused on ESJ communities. This framework includes the following steps:⁴²

- 1) Assess the communities' needs, identify indicators, and set goals;
- 2) Establish community-led decision making;
- 3) Develop metrics and a plan for tracking clean energy benefits and community benefits;
- 4) Ensure funding and program leveraging;
- 5) Improve outcomes by setting up a continuous feedback loop and considering adjustments.

For each of these steps, The Greenlining Institute identifies a set of questions that policymakers should ask and lays out recommendations. To assess the communities' needs, identify indicators, and set goals, they also explain how to set goals that are strategic, measurable, ambitious, realistic, time-bound, and equitable. This framework provides important steps in addition to the framework developed in this report.

RMI - eLab Accelerator 2020

RMI is a nonprofit organization that works with businesses, policymakers, communities, and other organizations to decarbonize energy systems.⁴³ Their eLab (Electricity Innovation Lab) convenes energy practitioners to discuss energy transition problems.⁴⁴ The eLab Accelerator is a bootcamp where project

⁴² The Greenlining Institute (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.

⁴³ RMI (n.d.). *Get to Know Us*. <https://rmi.org/about/>

⁴⁴ RMI (n.d.). *ELab: Electricity Innovation Lab*. <https://rmi.org/our-work/electricity/elab-electricity-innovation-lab/>

teams bring their challenges and potential solutions to the table.⁴⁵ In 2020, the topic of the eLab Accelerator was electrification and natural gas decommissioning in Berkeley.⁴⁶ The team included leaders and scientists from the City of Berkeley, PG&E, the California Energy Commission, the California Public Utilities Commission, the California Housing Partnership, and the Natural Resources Defense Council. The team “developed draft criteria and methodology for identifying and prioritizing pilot locations with equity, emissions, safety, health, and economic considerations in mind”.⁴⁷ The pilot resulting from the bootcamp will include a focus on low-income households, the utility’s obligation to serve, and financial barriers created by regulatory constraints.⁴⁸

First, the pilot will include at least one low-income neighborhood that best serves to identify financial and nonfinancial costs, benefits, and barriers. The pilot will address the community buy-in process, create transparency around regulatory financial barriers, and identify multiple funding mechanisms to scale. Second, the pilot aims to address the limitations of decommissioning specific gas distribution lines due to the utility’s obligation to serve, because it is not guaranteed that customers in decommissioned zones will not want to resume service. Therefore, the team is considering a “No Reconnect Ordinance” for buildings that have discontinued gas service. In addition, the city of Berkeley intends to work with the California Public Utilities Commission to modernize the concept of “obligation to serve” to prioritize adequate service, instead of obligation to provide both electricity and gas. Third, the team aims to identify where resources and funding streams are misaligned due to regulations that prevent utilities from paying for electrification projects with gas capital investments.⁴⁹ As one of the first efforts in the United States to address the decommissioning of gas distribution infrastructure and multi-building electrification,⁵⁰ this multidisciplinary boot camp serves as a great example of the potential challenges and solutions in designing a geographical electrification approach.

Common Spark Consulting - The Flipside Report

Common Spark Consulting is an independent firm that provides consulting services in public and stakeholder engagement, policy research and advocacy, and organizational development and strategy.⁵¹ Common Spark Consulting developed *The Flipside Report: A White Paper on Targeted Geographic Electrification in California’s Gas Transition* for Building Decarbonization Coalition, an organization that “unites building industry stakeholders with energy providers, environmental organizations and local governments to help electrify California’s homes and workspaces with clean energy”.⁵² The Flipside Report focuses on the flipside

⁴⁵ RMI (n.d.). *ELab Accelerator*. <https://rmi.org/our-work/electricity/elab-electricity-innovation-lab/elab-accelerator/>

⁴⁶ RMI (n.d.). *ELab Accelerator 2020: Berkeley Electrification and Natural Gas Decommissioning Pilot*.

⁴⁷ RMI (n.d.). *ELab Accelerator 2020: Berkeley Electrification and Natural Gas Decommissioning Pilot*.

⁴⁸ RMI (n.d.). *ELab Accelerator 2020: Berkeley Electrification and Natural Gas Decommissioning Pilot*.

⁴⁹ RMI (n.d.). *ELab Accelerator 2020: Berkeley Electrification and Natural Gas Decommissioning Pilot*.

⁵⁰ RMI (n.d.). *ELab Accelerator 2020: Berkeley Electrification and Natural Gas Decommissioning Pilot*.

⁵¹ Common Spark Consulting (n.d.). *What We Do*. <https://www.common-spark.com/>

⁵² Building Decarbonization Coalition (n.d.). <https://www.buildingdecarb.org/>

of gas decommissioning—the need to proactively map out and manage an aligned, equitable, and cost-effective framework for targeted geographic electrification. The report proposes a three-phased approach for geographically targeted electrification:

- 1) Phase 1: Vulnerable communities. These communities should be prioritized, even if they overlap with the criteria of phases 2 and 3 or if they share distribution lines with industrial and large commercial customers.
- 2) Phase 2: Urgent safety and need-to-repair threats. In this phase, priority should be placed first on fully or nearly depreciated gas assets, then on assets with imminent and high-cost repairs and high priority safety replacement. An example of infrastructure that would be decommissioned in this phase is distribution lines that serve only residential and small commercial customers and that need mitigation of earthquake risk or methane leaks.
- 3) Phase 3: Viable and cost-effective ways to trim infrastructure. In this phase, the avoided cost of early decommissioning and discontinued maintenance should outweigh the upfront cost of proactive electrification.

The approach should be guided by four core principles:⁵³

- a) Providing vulnerable communities with financial support for building upgrades, engaging them in the decision making process, protecting them from eviction, and ensuring high performance of new appliances.
- b) Develop pilots that are cost-effective in the immediate future to quickly reduce ratepayer burdens, that demonstrate their value as market transformation opportunities, and that help grow consumer confidence in emerging technologies.
- c) Develop a methodology to collect and analyze quantitative and qualitative data to inform future programs.
- d) Engaging upfront with labor unions and workforce advocates for a just transition of the gas workforce and for full utilization of pilots as opportunities for training and workforce development.

Proposed Geographical Electrification Framework

In this report, we propose a methodology for the prioritization and selection of neighborhoods for a geographically-targeted electrification approach. There are many challenges to creating a geographical decision framework, including how to determine which neighborhoods should transition first, what neighborhood characteristics or data will be used to select communities, how to identify distribution

⁵³ Common Spark Consulting (2021). *The Flipside Report: A White Paper on Targeted Geographic Electrification in California's Gas Transition*.

branches of the natural gas system that are strong candidates for retirement,⁵⁴ and how to successfully achieve electrification projects in the selected areas.⁵⁵ Our geographically-targeted framework draws upon the physical natural gas transmission and distribution infrastructure, community health risk and pollution burden, and low-income communities.

Key Considerations

In order to identify neighborhoods for prioritized electrification, we consider the physical infrastructure of the investor-owned utility natural gas system and community characteristics such as pollution burden and income level. We will use gas utility's transmission and distribution pipeline maps, the California Housing Partnership Affordable Housing map, and CalEnviroScreen to identify areas that are vulnerable to health risks and financial impacts.

Gas Infrastructure

To achieve a geographically-targeted approach to electrification, natural gas branch infrastructure needs to be identified that could be decommissioned independently of the natural gas system at large. We are targeting natural gas distribution branches that serve dedicated neighborhoods or areas, and that do not provide a through-path to other portions of the city. This approach is also called pruning, trimming, or zoning of the gas infrastructure. Branches that meet this criterion are identified as good candidates for independent decommissioning.

There are two types of gas pipelines: transmission lines and distribution lines. The crucial distinction between these two types of pipelines is the type of customers they serve. Transmission lines are high-pressure pipelines that mostly deliver gas to large-volume, noncore customers, such as electric generators, industrial customers, and large commercial customers. These transmission lines supply gas to distribution lines, which are lower-pressure pipelines that deliver gas to noncore customers who are not served by the transmission network, and to core customers, such as residential and small commercial customers.⁵⁶

Noncore customers are often more difficult to electrify than core customers. These “hard-to-decarbonize” sectors might benefit from the use of renewable natural gas (RNG), a resource that will likely remain too limited and expensive to decarbonize the building sector.⁵⁷ Therefore, initial efforts to decommission gas infrastructure are likely to be focused on distribution lines rather than transmission lines. However, limited data is publicly available on the distribution infrastructure of PG&E and SoCalGas.

⁵⁴ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

⁵⁵ California Energy Commission (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.

⁵⁶ CPUC (n.d.). *Natural Gas and California*. https://www.cpuc.ca.gov/natural_gas/

⁵⁷ RMI, Mina Lee & Sherri Billimoria (2021). *Eight Benefits of Building Electrification for Households, Communities, and Climate*.

While the San Francisco Bay Area in Northern California is served by PG&E, a utility company that provides both gas and electric service, the Los Angeles Area in Southern California is served by SoCalGas, a utility that provides exclusively gas service. As a result, both areas might experience different levels of adoption or resistance from the utilities as efforts start to shift towards gas infrastructure decommissioning and subsequent electrification, and therefore, they will require different strategies.

Public Health

This methodology considers communities with high health risks due to vulnerabilities caused by outdoor air pollution. Communities with high exposure to outdoor pollutants will likely also experience increased levels of air pollutants indoors, due to the direct connection between outdoor and indoor air quality.⁵⁸ The CalEnviroScreen pollution burden metrics are used to identify communities with significant pollution burdens. Targeted funding for identified areas in support of the transition to electricity will reduce the production of combustion pollutants in the outdoor and indoor environments, improving air quality and resulting in positive impacts on community health.

Low-Income Communities

Additional funding needs to be provided to support low-income communities through the transition from natural gas to all-electric infrastructure to prevent these communities from being the last remaining customers served by the natural gas system. We are proposing to use CalEnviroScreen to identify qualified communities.

Methodology

In this section, we will outline our methodology to identify priority neighborhoods during the electrification transition. Our process includes the following steps:

- 1) Use CalEnviroScreen to identify areas of interest. This can be based on the overall CalEnviroScreen results or specific indicators, such as prevalence of asthma, concentration of ozone and PM2.5, and housing-burdened low-income households.
- 2) Use natural gas pipeline maps to identify branches that serve only a small, dedicated area and thus could be decommissioned independent of the larger system.
- 3) Use the Affordable Housing Map to understand the locations of affordable housing developments and prioritize the electrification of these tenants to prevent risk of high natural gas utility bills in the future.

⁵⁸ EPA (n.d.). *Report on the Environment: Indoor Air Quality*. <https://www.epa.gov/report-environment/indoor-air-quality>

- 4) Use the Affordable Housing Map to identify the vintage of an affordable housing development. Give priority to older developments which may have older, less-efficient appliances resulting in increased energy costs to tenants and higher risk of indoor air pollutants.

Input Parameters

We used the following input parameters to identify neighborhoods for priority electrification: natural gas pipeline maps from two large investor-owned utility gas providers in California, Pacific Gas and Electric (PG&E) and Southern California Gas Company (SoCalGas), the Affordable Rental Housing Benefits Map from the California Housing Partnership, and CalEnviroScreen.

PG&E - Gas Pipeline Map

Pacific Gas and Electric (PG&E) is the company that delivers natural gas and electric service to approximately 16 million people in a 70,000-square-mile service territory throughout northern and central California, from Eureka to Bakersfield.⁵⁹ This report uses a map of PG&E's gas transmission pipelines.⁶⁰ While PG&E has a map with electric distribution circuits that indicates the number of residential, commercial, and industrial customers for each circuit,⁶¹ we could not find similar data on PG&E's gas distribution infrastructure.

SoCalGas - Gas Pipeline Map

Southern California Gas Company (SoCalGas) is the company that delivers natural gas to approximately 21.8 million people in a 24,000-square-mile service territory throughout central and southern California, from Visalia to the Mexican border.⁶² This report uses a map of SoCalGas' gas transmission pipelines and high-pressure distribution pipelines⁶³ to locate current gas infrastructure in that area. The SoCalGas map does not include low-pressure distribution lines, which would give a more detailed picture of how gas is transported to individual homes.

California Housing Partnership - Affordable Rental Housing Benefits Map

The California Housing Partnership is a private nonprofit organization that acts as a trusted advisor for nonprofit and local government partners as well as elected officials to create and preserve sustainable affordable housing.⁶⁴ The Affordable Rental Housing Benefits Map is a tool that provides "quantitative estimates of social and economic benefits of affordable housing for individual residents and families,

⁵⁹ PG&E (n.d.). *Company Profile*. https://www.pge.com/en_US/about-pge/company-information/profile/profile.page

⁶⁰ PG&E (n.d.). *Explore our Natural Gas Transmission Pipeline Map*.

⁶¹ PG&E (n.d.). *Solar Photovoltaic (PV) and Renewable Auction Mechanism (RAM) Program Map*.

⁶² SoCalGas (n.d.). *Company Profile*. <https://www.socalgas.com/about-us/company-profile>

⁶³ SoCalGas (n.d.). *Gas Transmission Pipeline Interactive Map*.

⁶⁴ California Housing Partnership (n.d.). *About Us*. <https://chpc.net/about-us/>

taxpayers, and the local economy”.⁶⁵ Affordable housing for low-income households is defined as housing for which the cost is no more than 30% of the gross household income. The California Department of Housing and Community Development defines low-income households as households who make less than 80% of the area median income.⁶⁶

The map contains detailed information on affordable housing with funding from the United States Department of Housing and Urban Development (HUD), the United States Department of Agriculture (USDA), and Low-Income Housing Tax Credit (LIHTC). The map also contains CalEnviroScreen 3.0, a Tax Credit Allocation Committee (TCAC) and California Department of Housing and Community Development (HCD) Opportunity Map, Federal Opportunity Zones, and California Assembly Bill 1550 (AB 1550) Low-Income Communities. At the time of writing, the property-level data was last updated on September 1, 2020.⁶⁷

CalEnviroScreen

CalEnviroScreen is a mapping tool developed by the California Public Utilities Commission that uses environmental, health, and socioeconomic information to help identify California disadvantaged communities. CalEnviroScreen defines disadvantaged communities as “areas throughout California which most suffer from a combination of economic, health, and environmental burdens”.⁶⁸

The tool uses data from state and federal government sources to produce scores for every census tract. Scores are determined for two groups of indicators, population characteristics and pollution burden, and higher scores indicate a higher prevalence of a given parameter.^{69,70} Population characteristics scores consist of sensitive population indicators such as occurrence of asthma, cardiovascular disease, and low-birth-weight infants; and socioeconomic factor indicators such as educational attainment, housing-burdened low-income households, linguistic isolation, poverty, and unemployment.⁷¹

Population characteristics related to biological traits, health status, and community can result in increased vulnerability to pollution.⁷² The pollution burden scores consist of indicators for exposure to ozone, particulate matter (PM) 2.5, diesel particulate matter, drinking water contaminants, pesticide use, toxic releases from facilities, traffic density, hazardous waste, and solid waste among others.⁷³

⁶⁵ California Housing Partnership (n.d.) *Affordable Housing Benefits Map*.

⁶⁶ Housing and Community Development (n.d.). *Income Limits*. <https://www.hcd.ca.gov/grants-funding/income-limits/index.shtml>

⁶⁷ California Housing Partnership (n.d.) *Affordable Housing Benefits Map*.

⁶⁸ CPUC (n.d.). *Disadvantaged Communities*. <https://www.cpuc.ca.gov/discom/>

⁶⁹ OEHHA (n.d.). *Maps & Data: CalEnviroScreen 3.0 Maps*. <https://oehha.ca.gov/calenviroscreen/maps-data>

⁷⁰ OEHHA (n.d.). *About CalEnviroScreen*. <https://oehha.ca.gov/calenviroscreen/about-calenviroscreen>

⁷¹ CalEPA & OEHHA (2017). *Update to the California Communities Environmental Health Screening Tool*.

⁷² OEHHA (n.d.). *Maps & Data: CalEnviroScreen 3.0 Maps*. <https://oehha.ca.gov/calenviroscreen/maps-data>

⁷³ OEHHA (n.d.). *CalEnviroScreen Overall Results and Individual Indicator Maps*.

In addition to looking at the overall pollution burden and overall population characteristics, this report focuses on three health indicators related to natural gas and two income characteristics related to low-income housing. The health indicators are asthma (nitrogen oxides and particulates released indoors due to burning of natural gas can cause asthma attacks), ozone (volatile organic compounds from the natural gas chain contribute to the formation of ozone)⁷⁴, and PM 2.5 (particulate matter is released when natural gas is burned). The income indicators are poverty (which means that the total income before taxes is less than the poverty level defined by the U.S. Census Bureau)⁷⁵ and housing burden (which means “households that are both low-income and highly burdened by housing costs”).⁷⁶

There are multiple definitions used by different utility and state government incentive programs to identify low-income communities for investment. Some programs use CalEnviroScreen, others identify low-income communities by the average area income. CalEnviroScreen has limitations and critiques, including the high-level nature of the data presented and the non-capture of “hyperlocal impacts”⁷⁷, the observation that the tool “may deprioritize rural and tribal lands”⁷⁸, the tool “does not incorporate climate impacts and resilience considerations”⁷⁹, and the tool omits “race and ethnicity indicators”.⁸⁰ Perhaps most importantly, some critics feel that the tool was developed without sufficient stakeholder engagement and discussion. This has caused some communities to feel “left out or insufficiently prioritized” by the tool if their community has not been identified as a qualified region for state investment.⁸¹

However, CalEnviroScreen is commonly used to allocate federal and state funds throughout the state of California, including the reinvestment of proceeds from the cap-and-trade market through the California Climate Investments (CCI) program broadly and the Transformative Climate Communities (TCC) program specifically.⁸² Because of its widespread use in California, and its use as a template for a federal mapping tool that the Biden administration is developing,⁸³ CalEnviroScreen was deemed the appropriate classification system to use for this study.

At the time of writing, CalEnviroScreen 4.0 was in the draft stage, so CalEnviroScreen 3.0 was used for the analysis. CalEnviroScreen 4.0 will contain more recent data, improved calculations of some indicators to

⁷⁴ Lesley Fleischman (2019). “How Does Natural Gas Production Contribute to Ozone Pollution?”. Clean Air Task Force.

⁷⁵ OEHHA (n.d.). *CalEnviroScreen Overall Results and Individual Indicator Maps*.

⁷⁶ OEHHA (n.d.). *CalEnviroScreen Overall Results and Individual Indicator Maps*.

⁷⁷ Aimee Barnes (2021). *Mapping Environmental Justice in the Biden-Harris Administration*. Center for American Progress.

⁷⁸ Aimee Barnes (2021). *Mapping Environmental Justice in the Biden-Harris Administration*. Center for American Progress.

⁷⁹ Aimee Barnes (2021). *Mapping Environmental Justice in the Biden-Harris Administration*. Center for American Progress.

⁸⁰ Aimee Barnes (2021). *Mapping Environmental Justice in the Biden-Harris Administration*. Center for American Progress.

⁸¹ Aimee Barnes (2021). *Mapping Environmental Justice in the Biden-Harris Administration*. Center for American Progress.

⁸² Aimee Barnes (2021). *How the Biden Administration’s Environmental Justice Mapping Tool Can Identify and Target Benefits to Disadvantaged Communities*. Legal Planet.

⁸³ Aimee Barnes (2021). *How the Biden Administration’s Environmental Justice Mapping Tool Can Identify and Target Benefits to Disadvantaged Communities*. Legal Planet.

better reflect environmental conditions or pollution vulnerability, and a new indicator for children's lead risk from housing.⁸⁴

Analysis of San Francisco Bay Area and Adjacent Central Valley

This section looks at the overall CalEnviroScreen results, the pollution burden, asthma, ozone, PM 2.5, the population characteristics, poverty, and housing burden for the San Francisco Bay Area and the adjacent Central Valley region. Figure 2 shows the overall results of CalEnviroScreen, where red areas represent the highest percentiles of the overall score (indicating the most disadvantaged areas) and green areas are the lowest percentiles. The dots indicate affordable housing units funded by HUD, USDA, and LIHTC. Blue dots indicate units that have been placed in service and grey dots indicate units that have not been placed in service. The dark blue lines indicate the locations of PG&E's natural gas transmission pipelines.

This map shows that disadvantaged areas are concentrated around the San Francisco Bay Area and in the Central Valley, and affordable housing is mostly located around the San Francisco Bay Area. To identify areas of interest, we can study indicators related to public health and income.

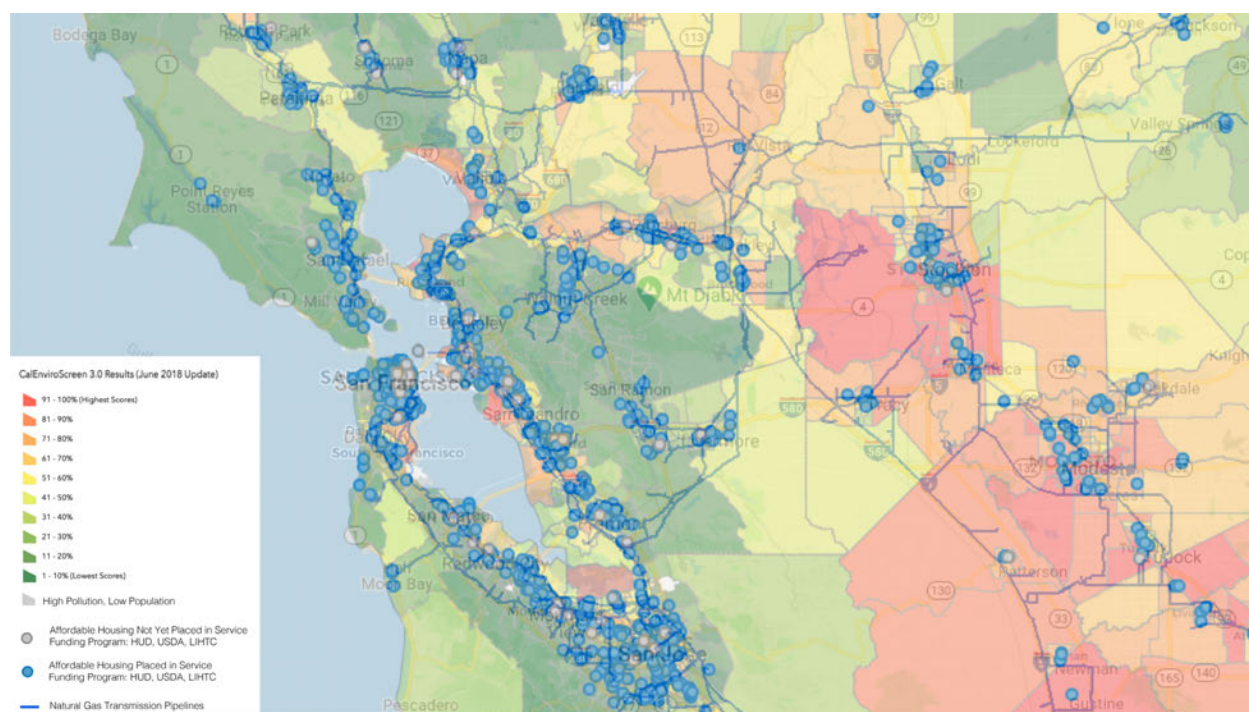


Figure 2: CalEnviroScreen **overall results**, affordable housing with funding from HUD, USDA, and LIHTC, and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

⁸⁴ OEHA (n.d.). *Draft CalEnviroScreen 4.0*. <https://oehha.ca.gov/calenviroscreen/report/draft-calenviroscreen-40>

Public Health

Figures 3, 4, 5, and 6 show the CalEnviroScreen pollution burden, asthma occurrence, ozone concentration, and PM 2.5 concentration. On all maps, the darkest areas are regions most burdened by a particular indicator, and PG&E transmission pipelines are indicated by dark blue lines. In addition, Figure 4 shows the location of emergency departments and Figures 5 and 6 show the location of monitors used to measure ozone and PM 2.5 concentrations.

The pollution burden is highest for many of the same areas which have the highest overall CalEnviroScreen scores (Figure 2). However, asthma occurrence is more concentrated in the East Bay (Berkeley, Oakland, San Leandro, Hayward) and the northern Central Valley (from Vallejo in the west to Stockton in the east). Ozone and PM 2.5 concentrations are highest around Stockton, Modesto, and Turlock. This indicates that the Central Valley should not be overlooked in electrification efforts.

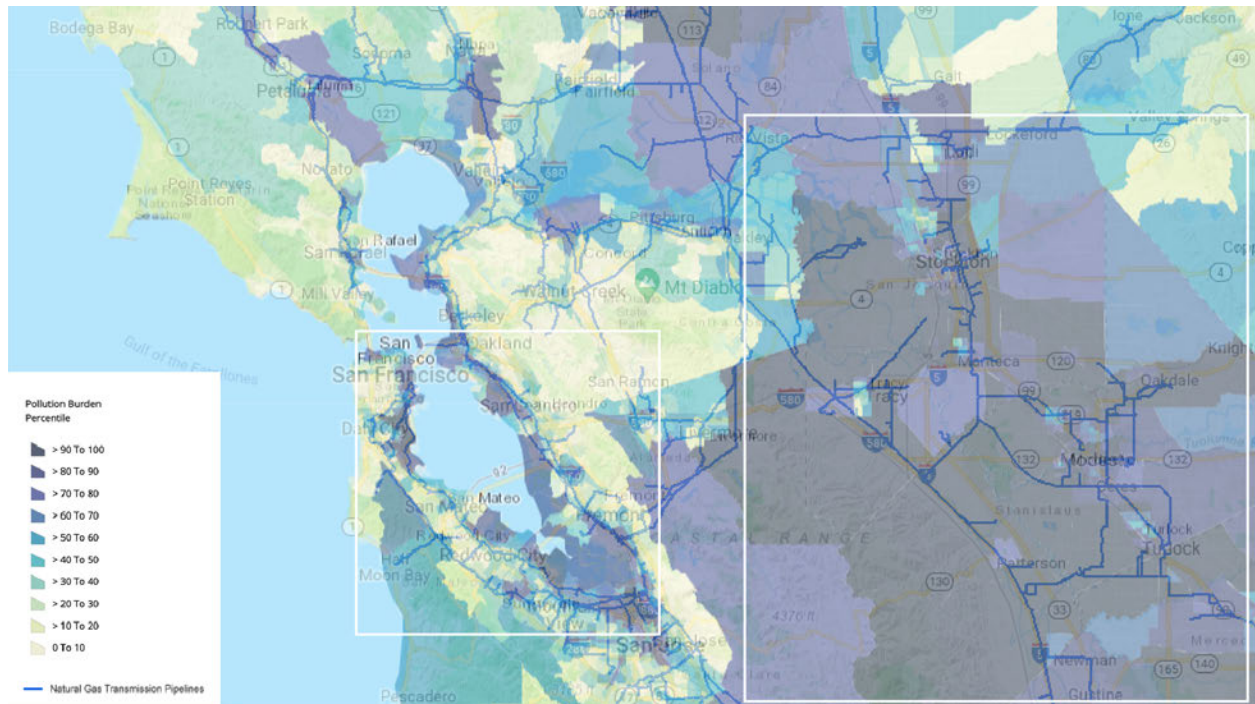


Figure 3: CalEnviroScreen **pollution burden** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

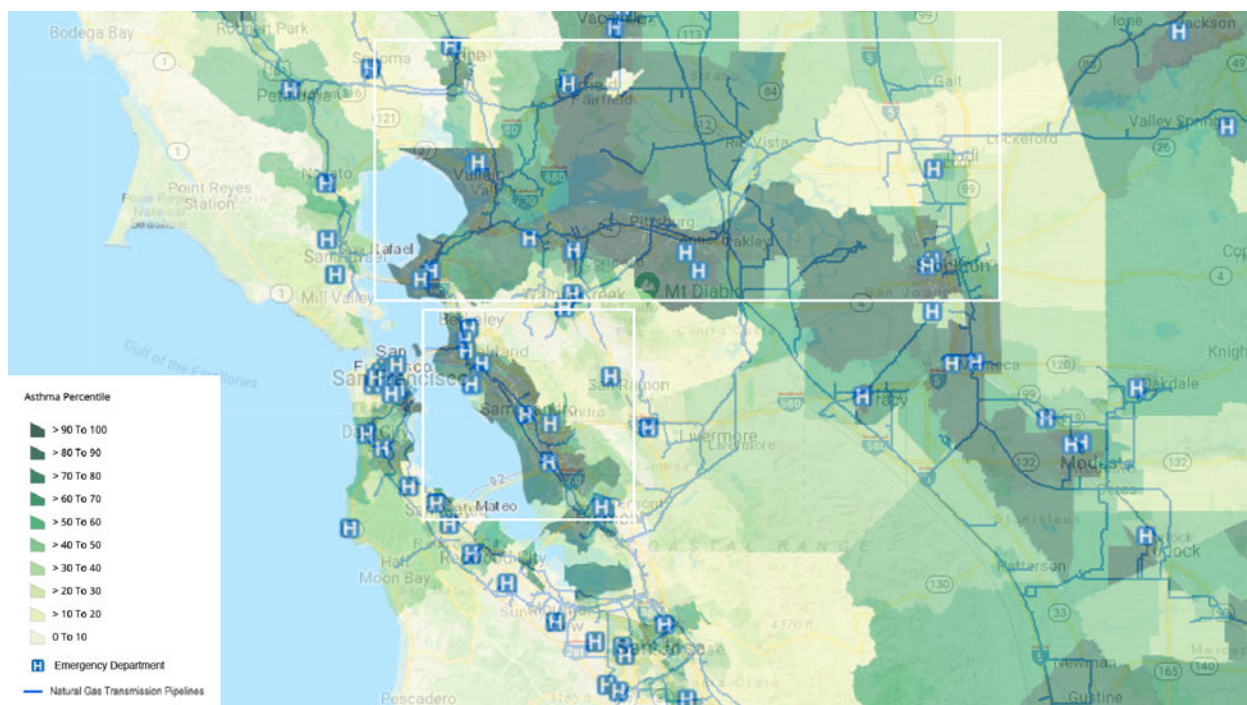


Figure 4: CalEnviroScreen **asthma** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

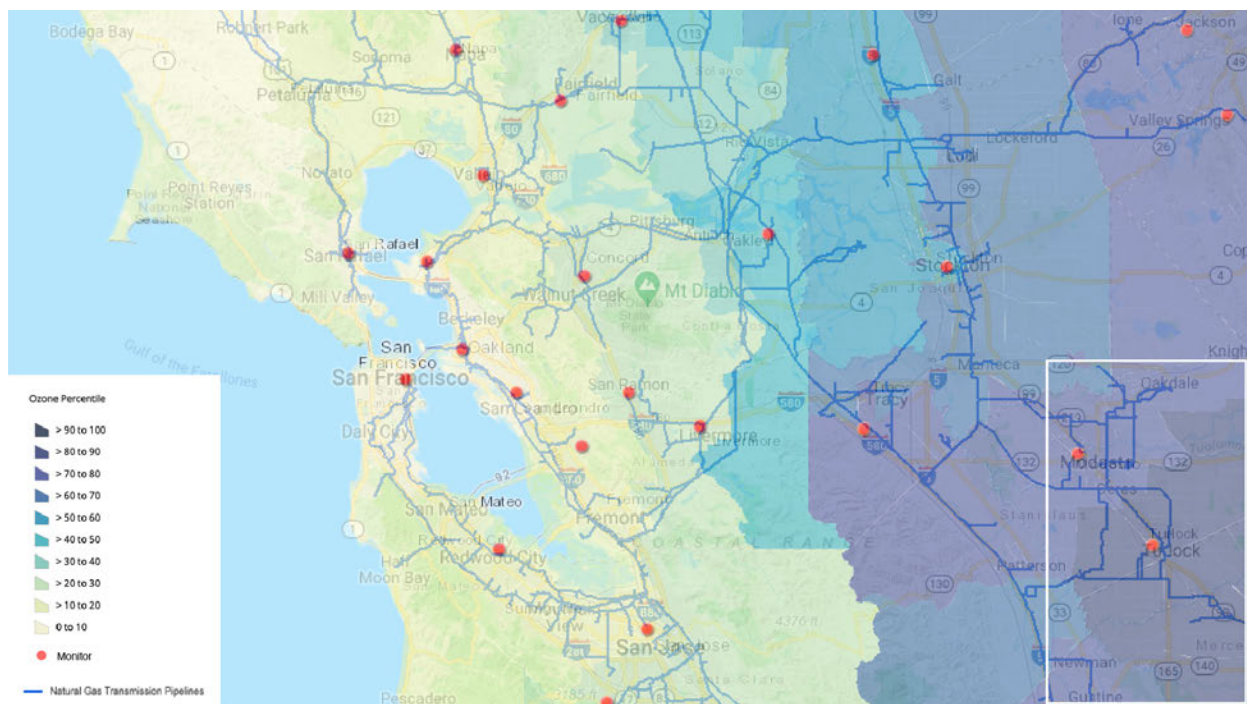


Figure 5: CalEnviroScreen **ozone** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

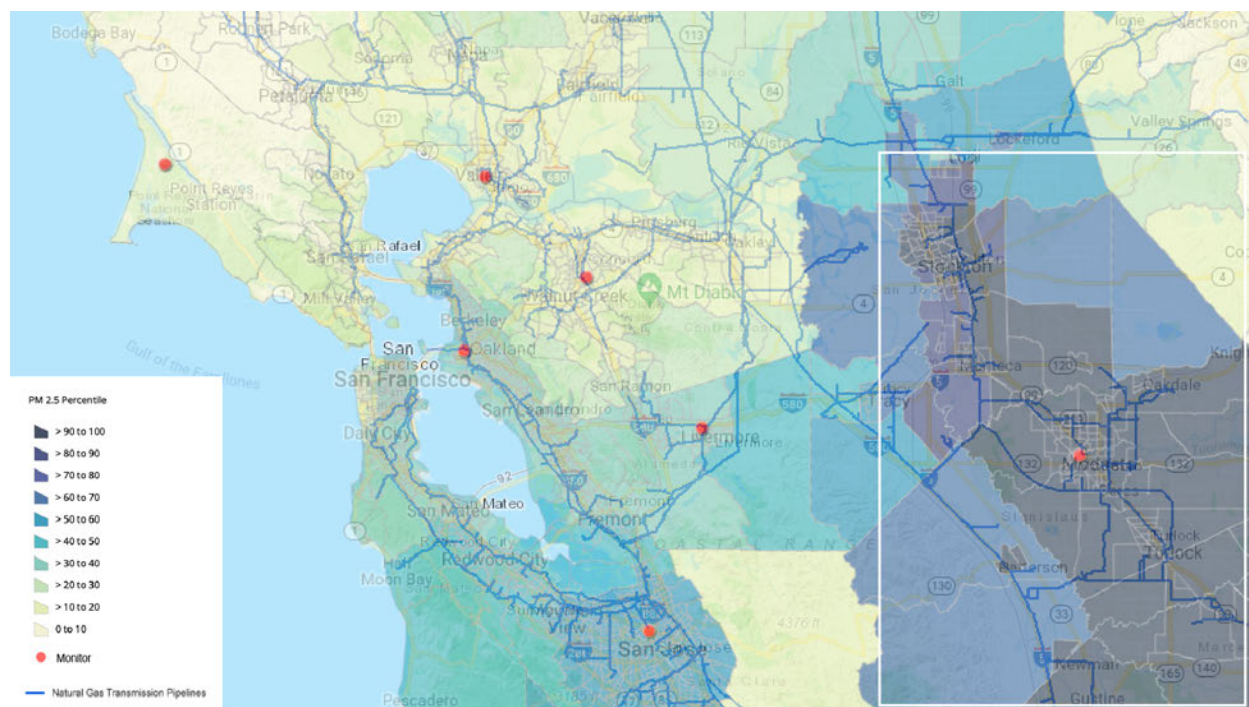


Figure 6: CalEnviroScreen **PM 2.5** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

Low-Income Communities

Figures 7, 8, and 9 show the CalEnviroScreen population characteristics, poverty, and housing burden. On all maps, the darkest areas are regions most burdened by a particular indicator, and PG&E transmission pipelines are indicated by dark blue lines.

The population characteristics again show that the most disadvantaged communities are located around the San Francisco Bay and in the Central Valley. However, the poverty and housing burden maps help us focus on communities that are particularly disadvantaged in terms of income and housing. Figure 8 shows a concentration of poverty around Stockton, Modesto, and Turlock in the Central Valley. Figure 9 shows that the housing burden is largest for people living in a few concentrated areas, including Oakland, San Jose, Stockton, and Modesto.

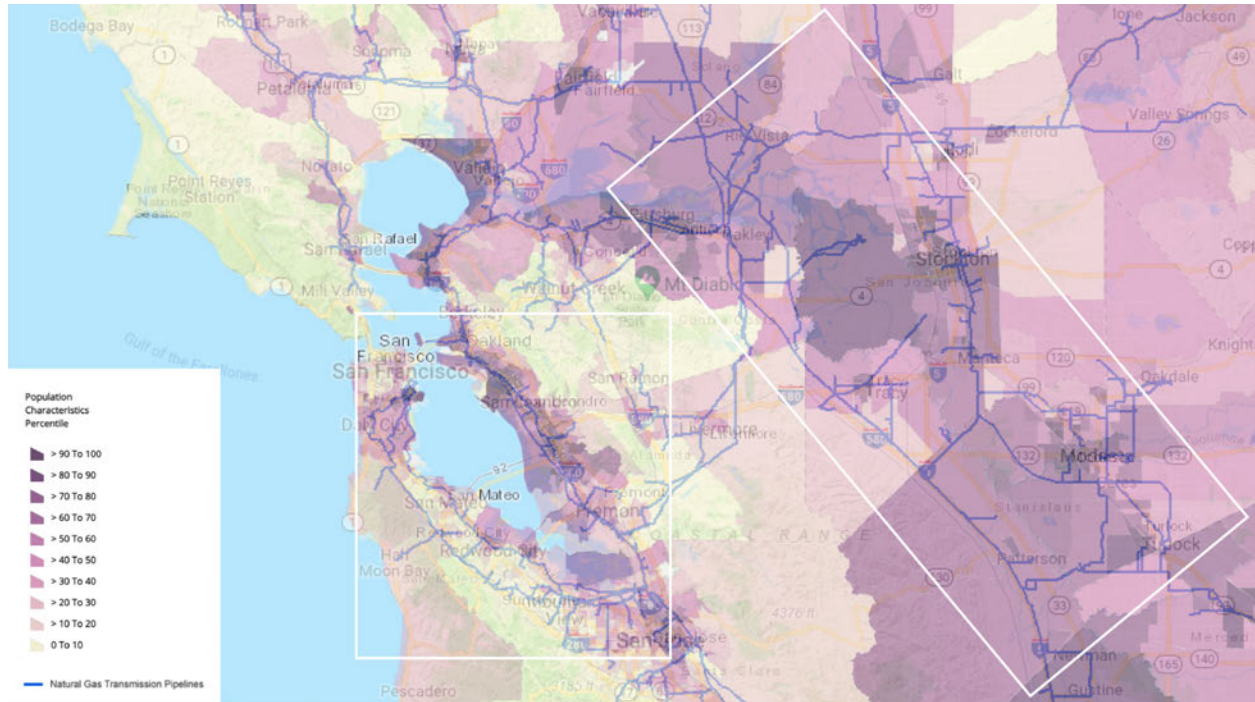


Figure 7: CalEnviroScreen **population characteristics** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

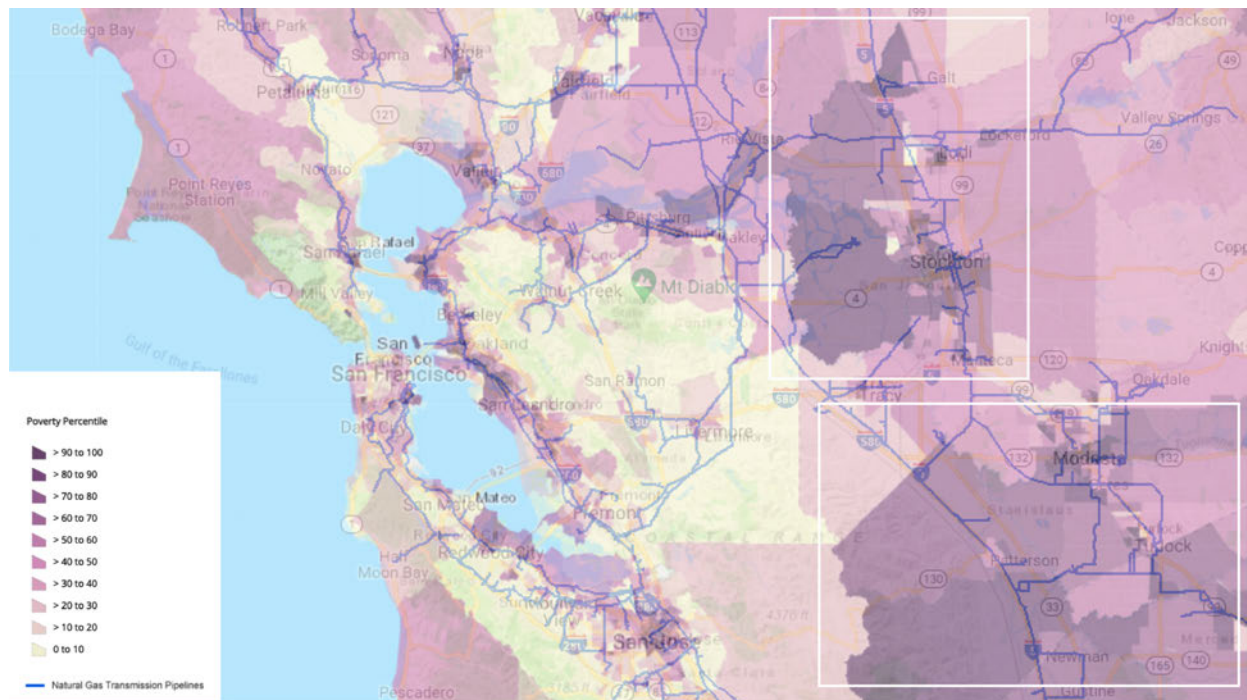


Figure 8: CalEnviroScreen **poverty** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

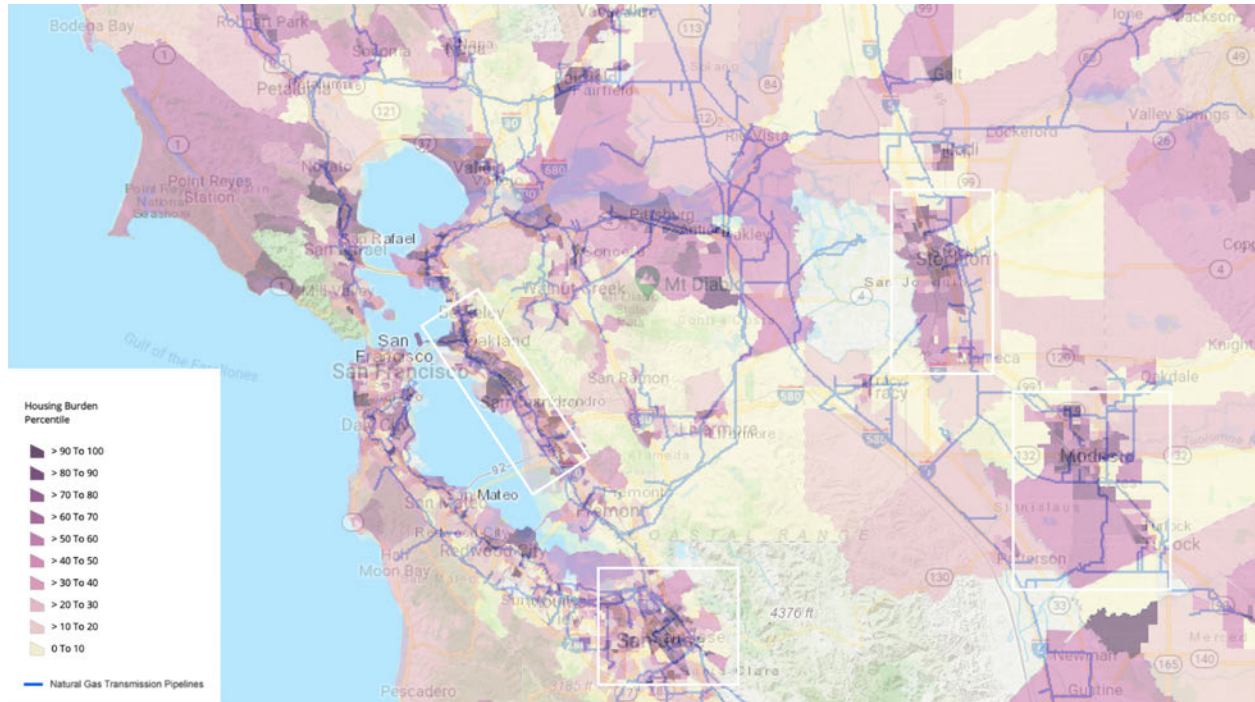


Figure 9: CalEnviroScreen **housing burden** and PG&E gas transmission pipelines in the San Francisco Bay Area and the adjacent Central Valley.

Case Study Central Valley: Stockton

Figure 10 uses Stockton as a case study of a geographically-targeted approach for electrification. Red areas are in the highest percentiles of the overall score (indicating the most disadvantaged areas) and green areas are the lowest percentiles. The dark blue lines are PG&E's gas transmission pipelines. The dots indicate affordable housing units funded by HUD, USDA, and LIHTC. Blue dots indicate units that have been placed in service (with the year they have been placed in service) and grey dots indicate units that have not been placed in service. While some older units are located on the periphery of Stockton, there is a clear concentration of affordable housing units in the center of the city, with years placed in service ranging from 1972 to 2019. This area has been indicated as a priority zone for electrification.

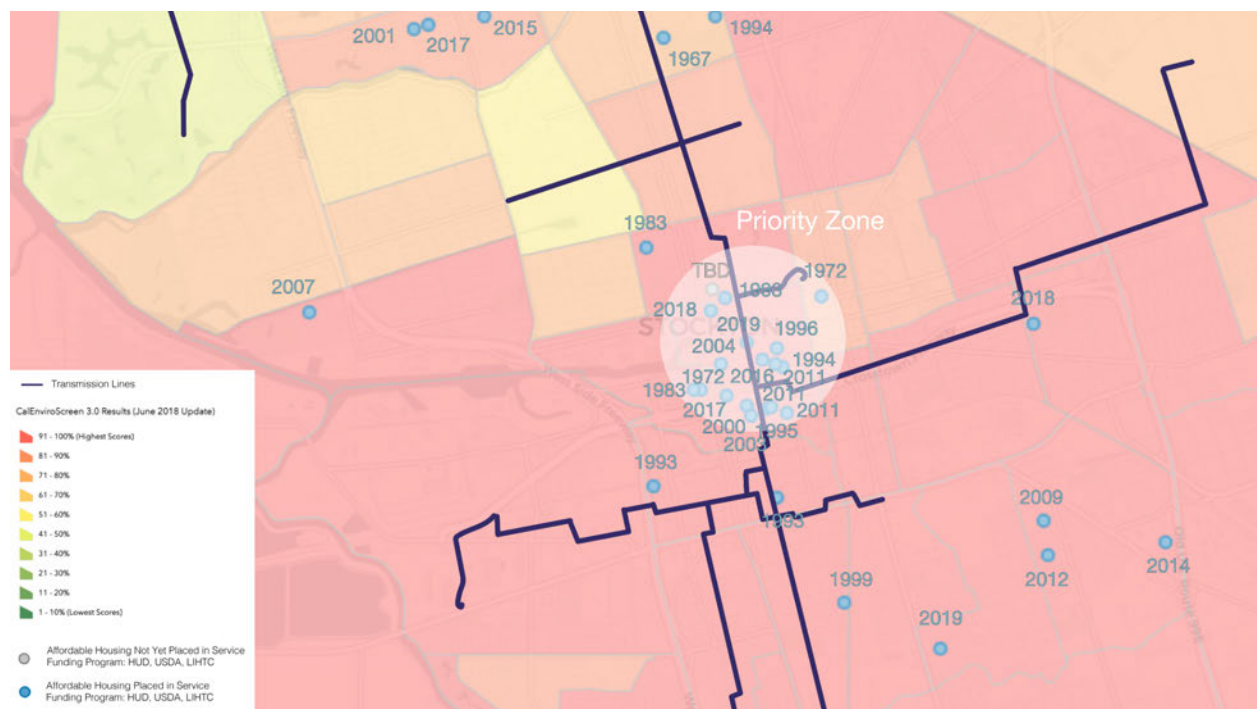


Figure 10: CalEnviroScreen overall results, affordable housing with funding from HUD, USDA, and LIHTC (the year indicates when the unit was placed in service), and PG&E transmission pipelines in **Stockton**.

Case Study Bay Area: Oakland

Figure 11 uses Oakland as a case study of a geographically-targeted approach for electrification. Affordable housing in Oakland is much more scattered, so we identified four priority zones based on clustering of units.

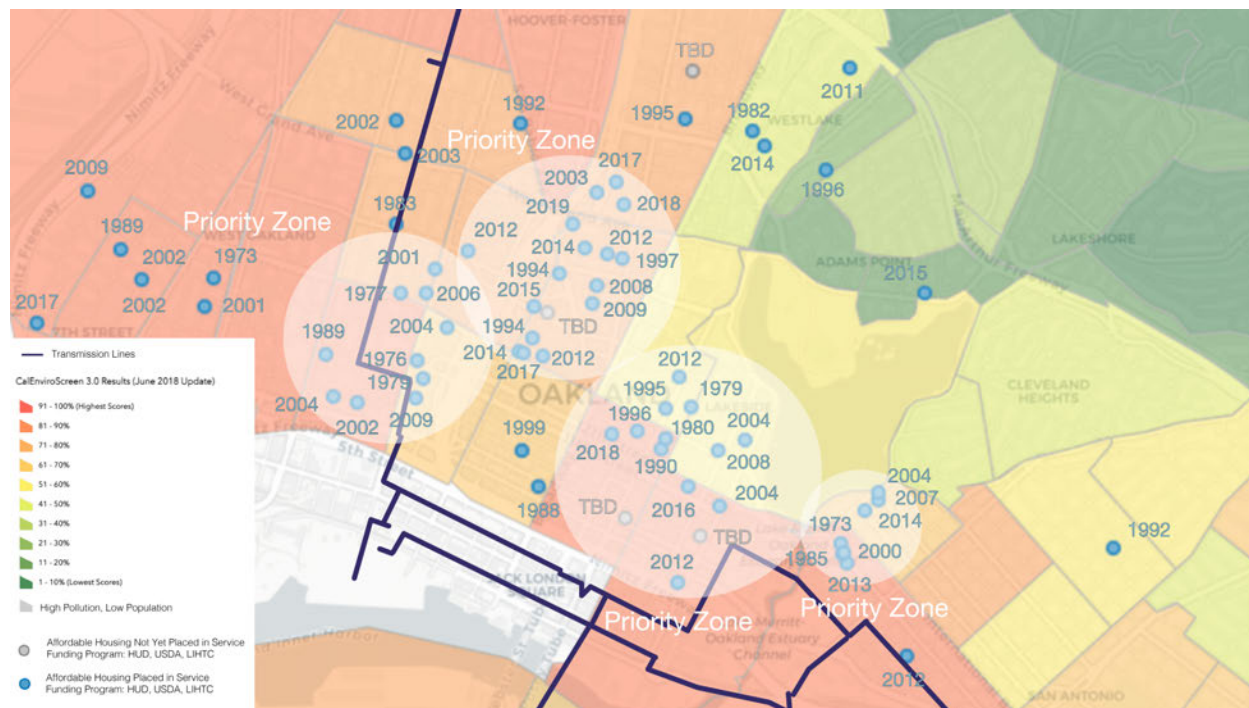


Figure 11: CalEnviroScreen overall results, affordable housing with funding from HUD, USDA, and LIHTC (the year indicates when the unit was placed in service), and PG&E transmission pipelines in **Oakland**.

Analysis of Los Angeles Area

This section looks at the overall CalEnviroScreen results, the pollution burden, asthma, ozone, PM 2.5, the population characteristics, poverty, and housing burden for the Los Angeles Area. Figure 12 shows the overall results of CalEnviroScreen, where red areas are in the highest percentiles of the overall score (indicating the most disadvantaged areas) and green areas are the lowest percentiles. The dots indicate affordable housing units funded by HUD, USDA, and LIHTC. Blue dots indicate units that have been placed in service and grey dots indicate units that have not been placed in service. The dark blue lines are SoCalGas' gas transmission pipelines and the light blue lines are its high-pressure distribution pipelines. With the exception of a few areas around Beverly Hills, Santa Monica, and Huntington Beach, disadvantaged areas are widespread, so it is even more important to focus on specific indicators to identify areas of interest.

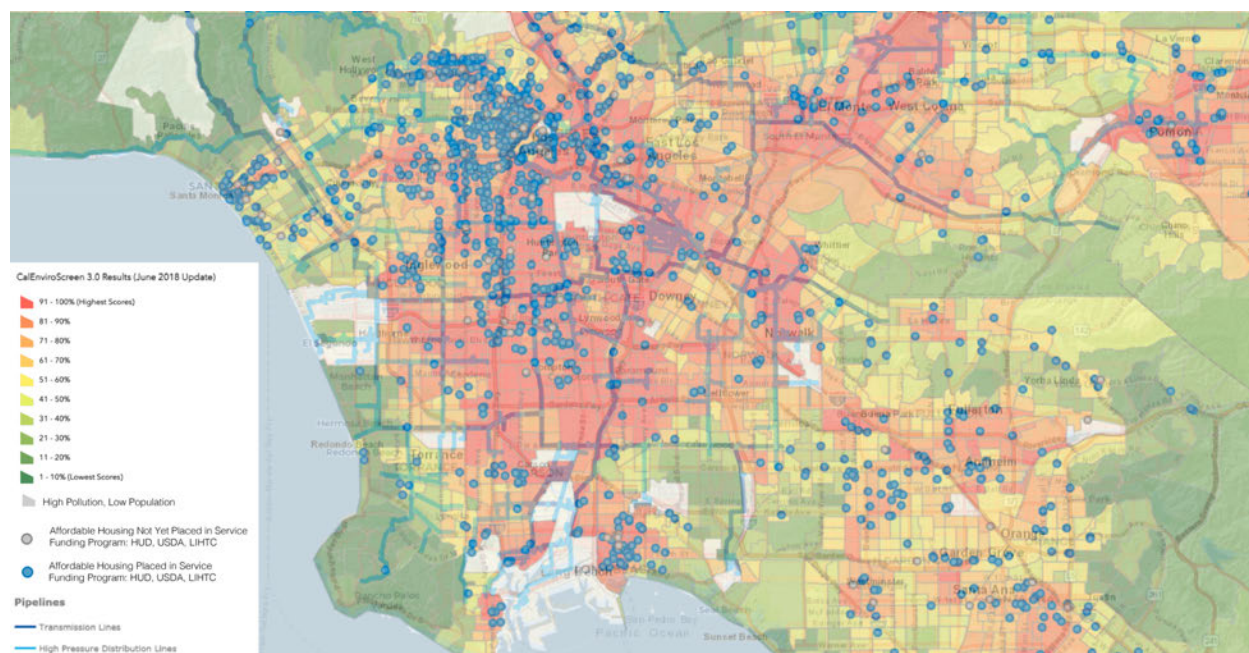


Figure 12: CalEnviroScreen **overall results**, affordable housing with funding from HUD, USDA, and LIHTC, and SoCalGas pipelines in the Los Angeles Area.

Public Health

Figures 13, 14, 15, and 16 show the CalEnviroScreen pollution burden, asthma occurrence, ozone concentration, and PM 2.5 concentration. On all maps, the darkest areas are the most burdened areas, SoCalGas transmission pipelines are indicated by dark blue lines, and high-pressure distribution pipelines are indicated by light blue lines. In addition, Figure 14 shows the location of emergency departments and Figures 15 and 16 show the location of monitors used to measure ozone and PM 2.5 concentrations.

The pollution burden is high for an area even larger than the disadvantaged area indicated by the CalEnviroScreen overall results. With the exception of Rancho Palos Verdes by the coast and some small areas in the east, most of the Los Angeles area belongs to the highest percentiles in terms of pollution burden. Asthma occurrence is slightly more concentrated in the area between Downtown Los Angeles and Compton. Ozone concentration on the other hand is smallest by the coast and increases gradually more inland, with the highest percentiles location around Pomona. PM 2.5 concentration is high in most of the Los Angeles area. Overall, an analysis of the health indicators does not contribute to identifying priority areas.

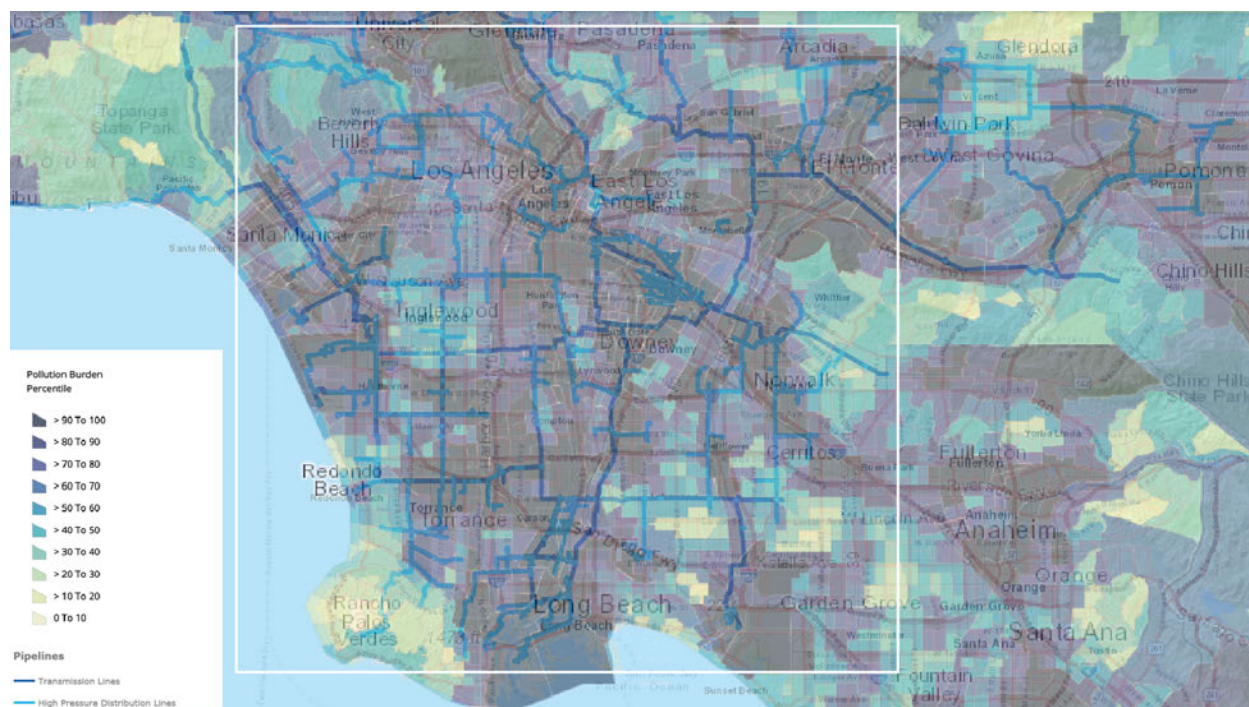


Figure 13: CalEnviroScreen **pollution burden** and SoCalGas pipelines in the Los Angeles Area.

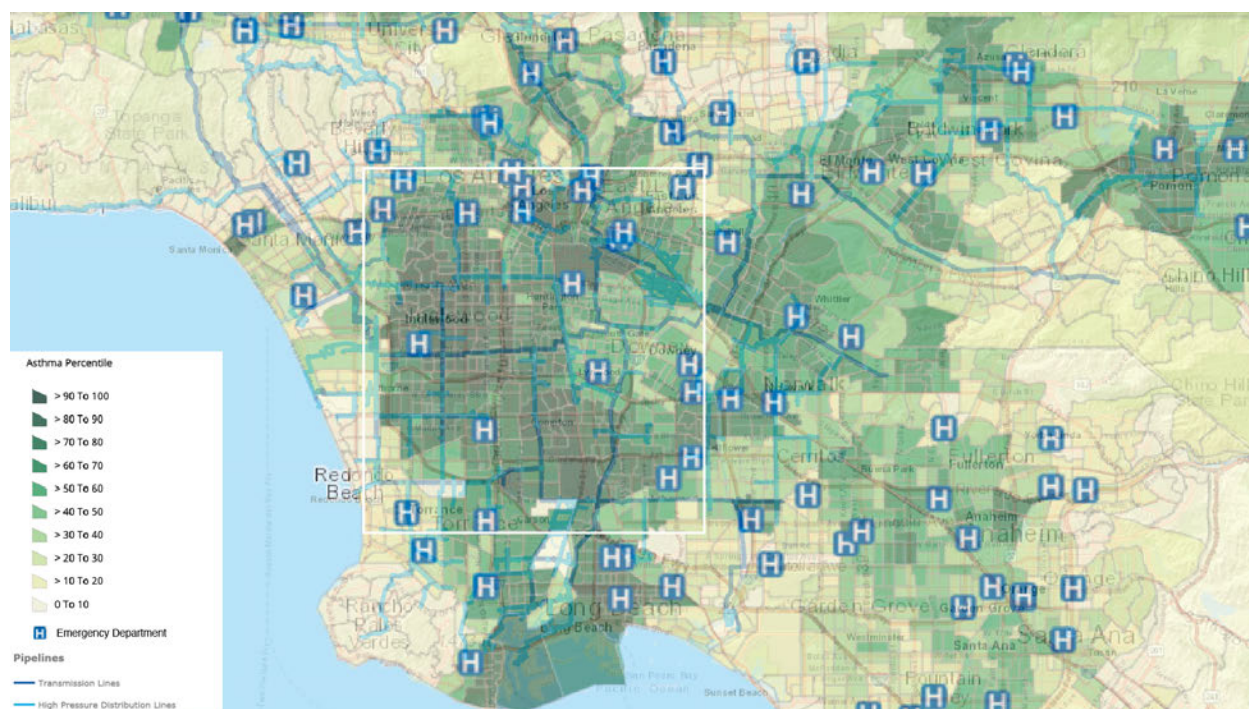


Figure 14: CalEnviroScreen **asthma** and SoCalGas pipelines in the Los Angeles Area.

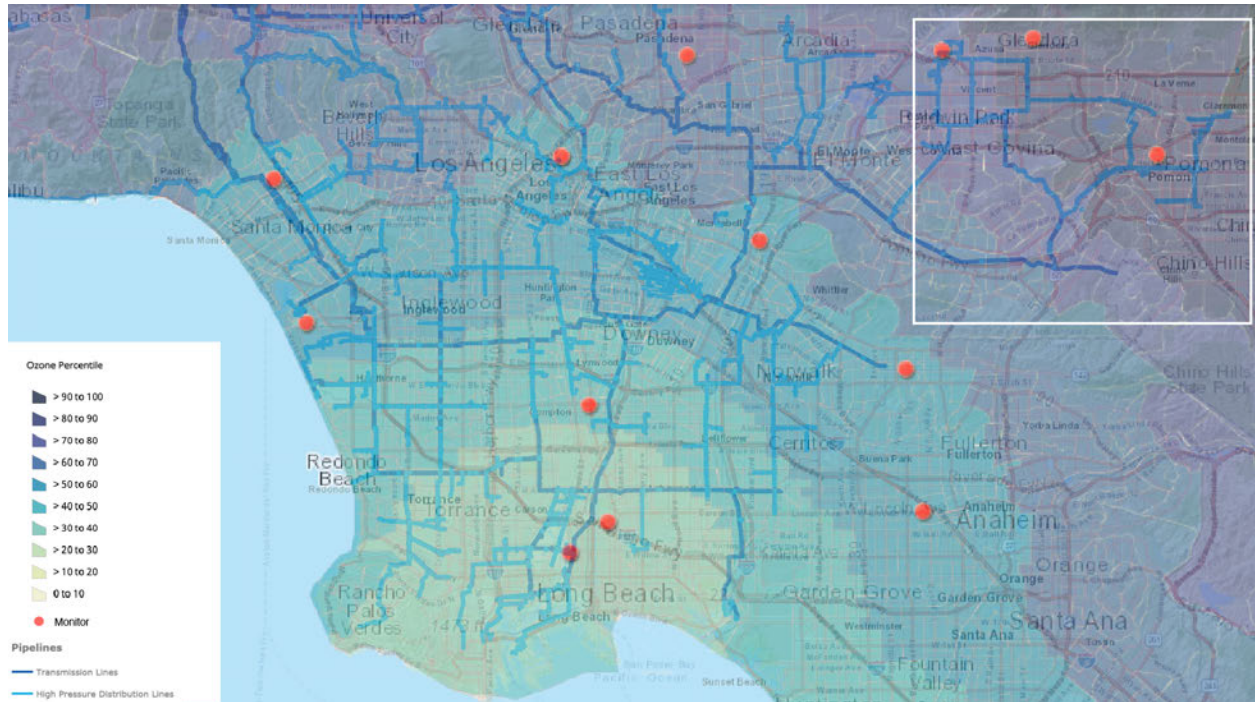


Figure 15: CalEnviroScreen **ozone** and SoCalGas pipelines in the Los Angeles Area.

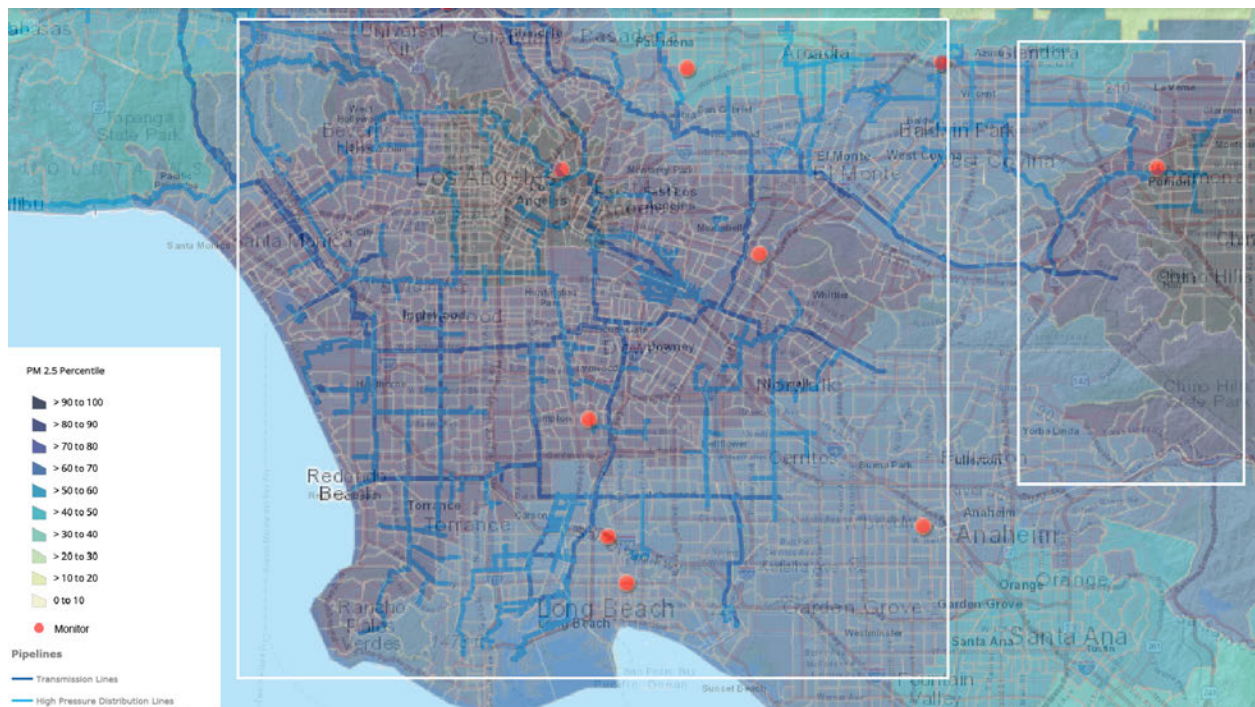


Figure 16: CalEnviroScreen **PM 2.5** and SoCalGas pipelines in the Los Angeles Area.

Low-Income Communities

Figures 17, 18, and 19 show the CalEnviroScreen population characteristics, poverty, and housing burden. On all maps, the darkest areas are the most disadvantaged areas, SoCalGas transmission pipelines are indicated by dark blue lines and high-pressure distribution pipelines are indicated by light blue lines.

The population characteristics show a concentration of disadvantaged communities between downtown Los Angeles in the north and Compton in the south, and Inglewood in the west and Downey in the east. Poverty and housing burden are concentrated in the same region and further help narrow down the priority area.

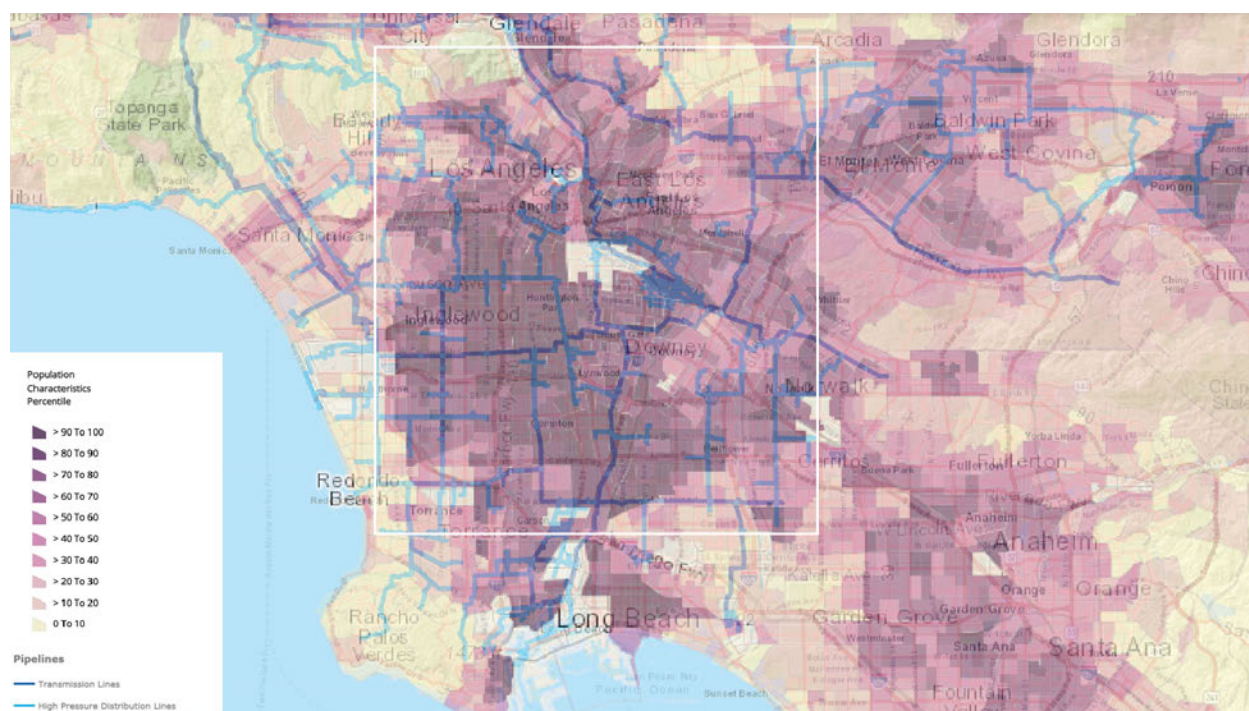


Figure 17: CalEnviroScreen **population characteristics** and SoCalGas pipelines in the Los Angeles Area.

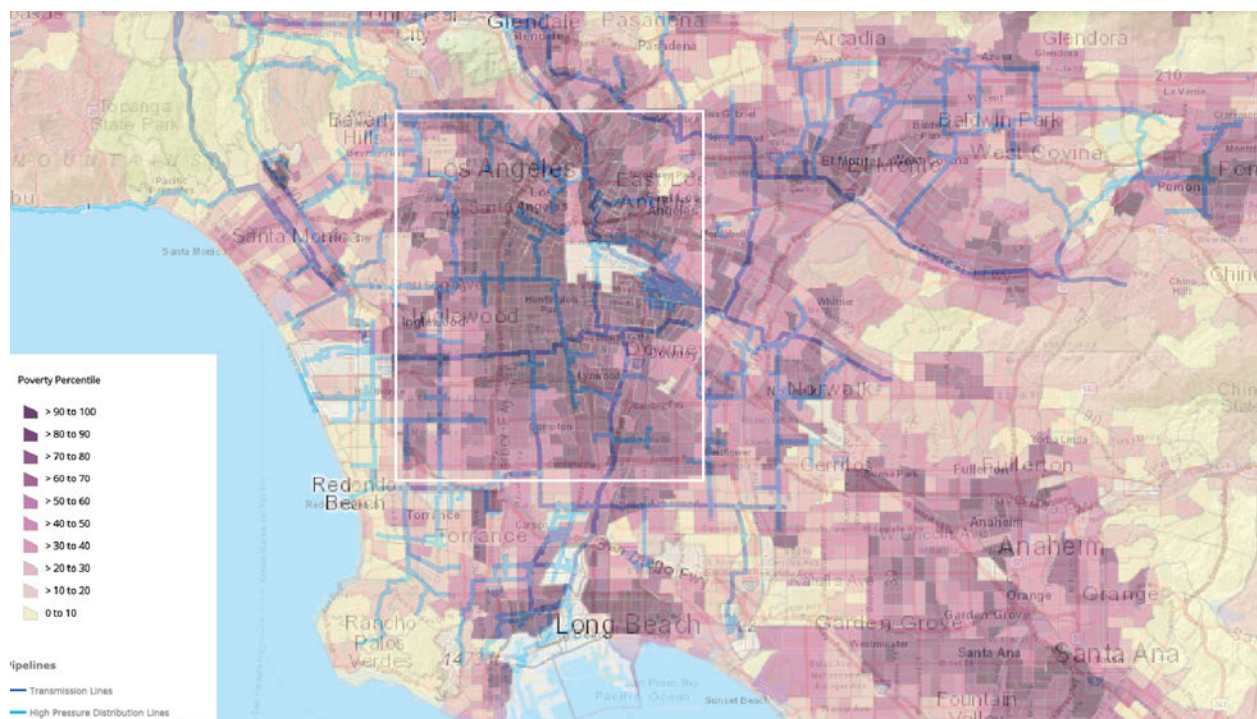


Figure 18: CalEnviroScreen **poverty** and SoCalGas pipelines in the Los Angeles Area.

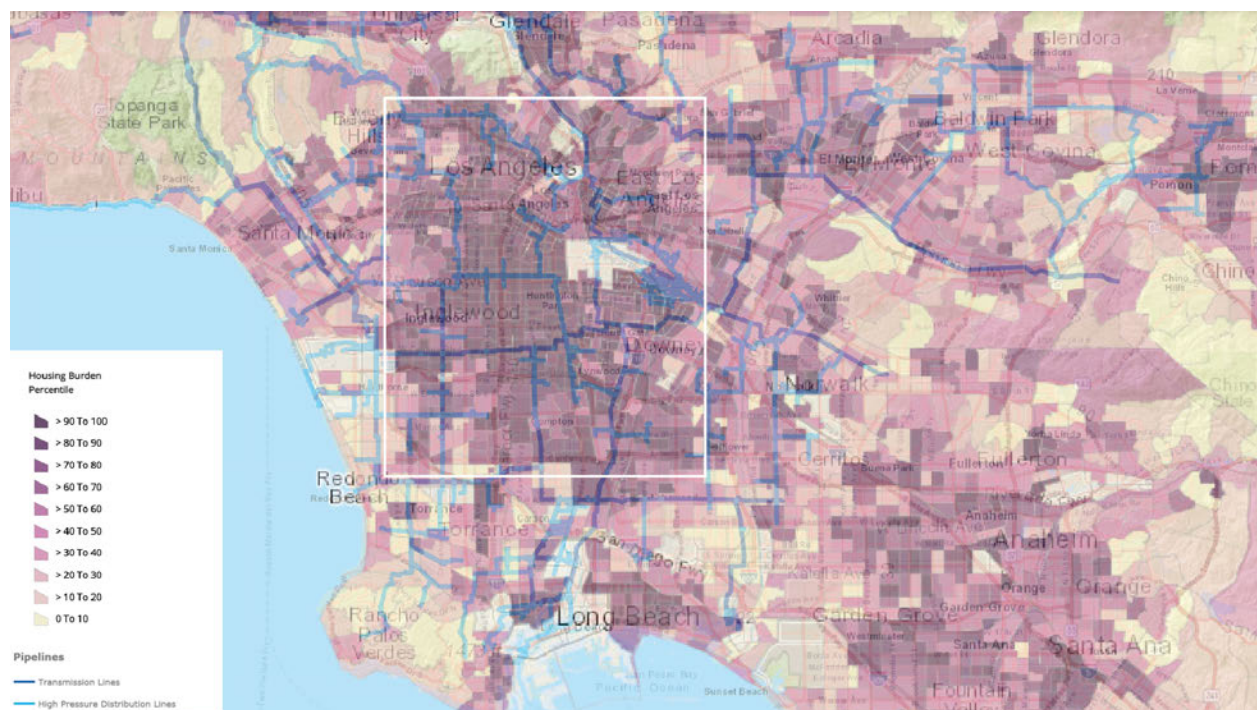


Figure 19: CalEnviroScreen **housing burden** and SoCalGas pipelines in the Los Angeles Area.

Case Study Los Angeles

Figures 20 and 21 use a more specific area south of Monterey Park as a case study of a geographically-targeted approach for electrification. To reiterate, red areas are in the highest percentiles of the overall score (indicating the most disadvantaged areas) and green areas are the lowest percentiles.

Figure 20 shows potential phases in which gas infrastructure could be decommissioned. Phase 1 (white) consists of outer branches of the distribution infrastructure. Phase 2 (light purple) consists of branches that connect lines from Phase 1 to other infrastructure. Phase 3 (mid purple) consists of branches that connect lines from Phase 2 to other infrastructure. Finally, Phase 4 consists of transmission lines.

Figure 21 zooms in on the neighborhood indicated by the frame in Figure 20, between Commerce in the north and Bell Gardens in the south. Again, pipelines are grouped into phases 1 to 4. The blue dots indicate affordable housing units funded by HUD, USDA, and LIHTC that have been placed in service (with the year they have been placed in service). From the clustering of affordable housing units, we can deduce three clear priority zones. In addition, the age of the affordable housing units can help determine a potential hierarchy for the priority zones, with the oldest units prioritized first.

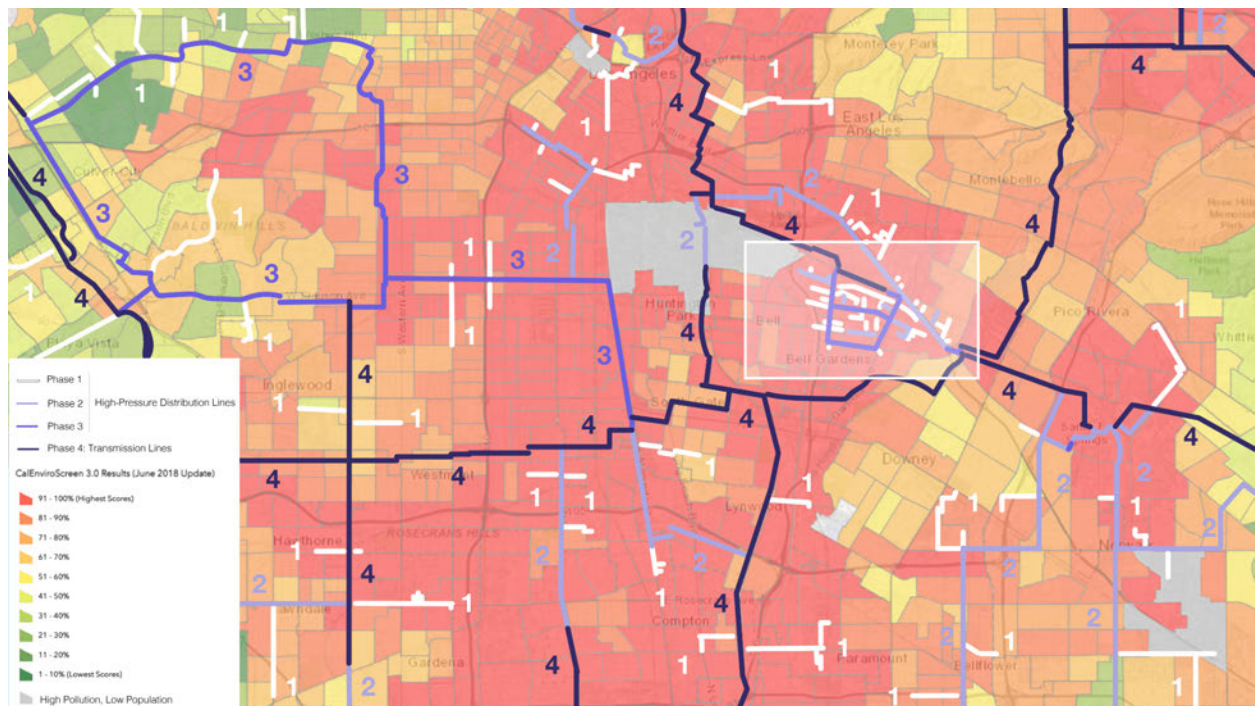


Figure 20: CalEnviroScreen overall results and SoCalGas pipelines between Monterey Park (north) and Paramount (south).

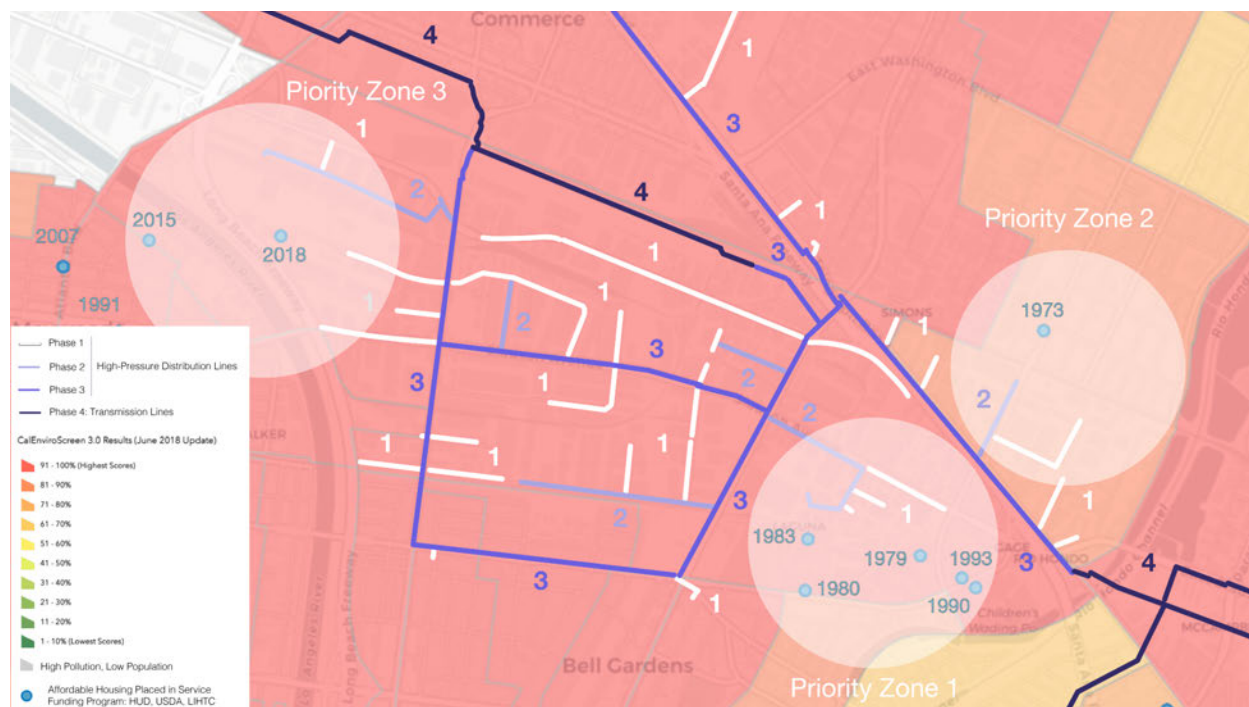


Figure 21: CalEnviroScreen overall results and SoCalGas pipelines between Commerce (north) and Bell Gardens (south).

Proposed Policies in Support of the Geographical Framework

In order for a geographically-targeted electrification transition to be successful in ESJ communities, and to support and preserve affordable housing, it is critical that specific policy mechanisms are put into place. Based on research and advice from experts in the field, we have compiled the following list of policy recommendations.

Avoid Expansion of the Gas System

Policies need to be established to restrict new construction of gas infrastructure. Cities across California have already enacted reach codes to eliminate natural gas and to move to all-electric new construction projects.⁸⁵ A recent roundtable hosted by California Housing Partnership found that “[service] providers agreed that for new construction, initial equipment and installation costs [of all-electric systems] are now comparable to gas infrastructure in the majority of situations.”⁸⁶ Continuing to increase the reach of the natural gas distribution system is going to continue to increase the financial burden on future Californians, who will be financially responsible for the cost to operate and maintain the network, including affordable housing developments and

⁸⁵ California Energy Codes and Standards (n.d.). *Statewide Reach Codes Program*. <https://localenergycodes.com/>

⁸⁶ California Housing Partnership (2021). *Prioritizing California’s Affordable Housing in the Transition Towards Equitable Building Decarbonization*.

ESJ communities. As more buildings become all electric, customers who do not have the financial resources or the autonomy to upgrade their homes, such as renters, may result in affordable housing and ESJ communities being the last remaining customers on the system. Expanding the natural gas system will continue to increase the cost of gas service for remaining customers served by the system.⁸⁷ Freezing the expansion of California's natural gas infrastructure could be implemented at the state level, either by the California Energy Commission through code or by the California Air Resource Board through increased air quality regulations.

Rent Protections for Tenants

Policies need to specifically support tenants through the electrification process and provide protections against rent increases, displacement, and possible reductions in naturally occurring affordable housing availability.⁸⁸ As owners of naturally occurring affordable housing projects invest in electrification of their buildings, one possible unintended impact could include rent increases for tenants.⁸⁹ Assurances need to be provided to protect rental affordability, such as those included in the Low-Income Weatherization Program (LIWP) which prevent owners from raising rents following the completion of building updates sponsored by the program.^{90,91}

Provide Sufficient Funding for Building Owners

Financial support needs to be provided to owners of affordable housing developments to fully incentivize the transition from natural gas to electricity. Incentive programs do exist to support this transition, but some experts argue that it is not enough.^{92,93} The Sierra Club has provided the general advice to “improve affordability of electrification with incentives, rate reform, and financing, with a priority focus on low-income residents.”⁹⁴ In addition to other affordable housing funding opportunities, the California Housing Partnership roundtable participants also suggested that additional tax credits be awarded to projects that are all electric, and that the state should provide more money for decarbonization in affordable housing retrofits.⁹⁵

⁸⁷ California Energy Commission (2020). The Challenge of Retail Gas in California's Low-Carbon Future.

⁸⁸ NRDC, CHPC, Earthjustice, Sierra Club (2020). *Comments on AB 3232 May 22 2020 Workshop*.

⁸⁹ NRDC, CHPC, Earthjustice, Sierra Club (2020). *Comments on AB 3232 May 22 2020 Workshop*.

⁹⁰ Sierra Club (2019). *Building Electrification Action Plan for Climate Leaders*.

⁹¹ Department of Community Services and Development (2019). *Low-Income Weatherization Program: Program Guidelines*.

⁹² California Housing Partnership (2021). *Prioritizing California's Affordable Housing in the Transition Towards Equitable Building Decarbonization*.

⁹³ AEA, Nick Dirr & Sheetal Chitnis (2020). *Multifamily Clean Heating Pilot: Summary of Project-level Analysis and Findings*.

⁹⁴ Sierra Club (2019). *Building Electrification Action Plan for Climate Leaders*.

⁹⁵ California Housing Partnership (2021). *Prioritizing California's Affordable Housing in the Transition Towards Equitable Building Decarbonization*.

Create Synergies Among Incentive Programs

There is a lot of interest in creating new electric-specific incentive programs that are very closely aligned with existing programs and share the same qualification requirements. There are suggestions to “align affordable housing incentives programs with decarbonization” including through the operation of the Tax Credit Allocation Committee (TCAC), California Debt Limit Allocation Committee (CDLAC), and Affordable Housing and Sustainable Communities (AHSC).⁹⁶ There was also feedback to “remove silos between affordable housing and energy programs,”⁹⁷ and pair energy efficiency programs and solar programs together in conjunction with electrification programs, which was a key motivator for participants in the BayREN clean heating multifamily pilot program.⁹⁸

Support All-Electric Equipment and Provide Technical Assistance

There also seems to be agreement that policy action needs to be taken to provide additional support to the electrification equipment market and technical assistance in the design process. New policies need to follow the blueprint of the California Solar Initiative (CSI) and encourage heavy investment in all electric equipment and appliances,⁹⁹ in order to make them low-cost, and to ensure that they are readily available for all-electric new construction mandates and to “transform the market for high-efficiency electric equipment.”¹⁰⁰ Policy also needs to dedicate funds for robust technical assistance¹⁰¹ and address the “need for additional contractor knowledge and availability”.¹⁰²

Redefine the Obligation to Serve

Policy support needs to be given to redefine the utility’s obligation to serve. As a natural monopoly, the utility is obligated to serve all customers within its service territory. Currently, there is concern that a utility would be responsible for providing natural gas service to a future customer who is located along a distribution line that was previously decommissioned. This would require the utility to reinstate the distribution line or provide new infrastructure at great cost. Legislation will need to be enacted at the state level “to provide clear directive to the CPUC and regulated utilities that obligation to serve can be met by a different fuel, and that the state authorizes the CPUC to allow for replacement to happen in scenarios where a non-pipeline alternative is

⁹⁶ NRDC, CHPC, Earthjustice, Sierra Club (2020). *Comments on AB 3232 May 22 2020 Workshop*.

⁹⁷ NRDC, CHPC, Earthjustice, Sierra Club (2020). *Comments on AB 3232 May 22 2020 Workshop*.

⁹⁸ AEA, Nick Dirr & Sheetal Chitnis (2020). *Multifamily Clean Heating Pilot: Summary of Project-level Analysis and Findings*.

⁹⁹ NRDC, Olivia Ashmoore (2020). *Policy Pathways to Zero-Emissions Buildings*.

¹⁰⁰ NRDC, CHPC, Earthjustice, Sierra Club (2020). *Comments on AB 3232 May 22 2020 Workshop*.

¹⁰¹ AEA, Nick Dirr & Sheetal Chitnis (2020). *Multifamily Clean Heating Pilot: Summary of Project-level Analysis and Findings*.

¹⁰² AEA, Nick Dirr & Sheetal Chitnis (2020). *Multifamily Clean Heating Pilot: Summary of Project-level Analysis and Findings*.

more cost-effective.”¹⁰³ The obligation to serve needs to be redefined as the requirement to provide customers with a sufficient utility connection, with no explicit or implicit fuel requirements.

Suggestions for Future Work

In order for a more complete analysis of how gas infrastructure can be decommissioned, it is imperative that utilities make more detailed information publicly available, particularly on gas distribution lines. Such data could include the age, state, and material of the transmission and distribution lines, plans for replacement and maintenance, and natural gas leaks. In addition, data on which distribution pipelines serve both core and noncore customers would help identify lines that are more difficult to decommission.

While this report focuses on public health and low-income communities as parameters for a decommissioning framework, additional inputs could be areas prone to public safety power shut offs (PSPS) and wildfires. These areas are in great need of increased resilience, which could be aided by electrification. PG&E has a map with current outages with an indication of the number of customers affected and future PSPS outages with the affected areas.¹⁰⁴ Similarly, SCE has a map with power shut offs, areas under PSPS consideration, high-risk fire areas, and areas served by circuits that cross into high-risk fire areas.¹⁰⁵ SDG&E has a map of unplanned outages and planned active and future outages.¹⁰⁶

For our analysis of affordable housing that should be prioritized, we only took into consideration the year that the housing complex was placed into service. However, funding cycles of the Low-Income Housing Tax Credit (LIHTC) Program by the California Tax Credit Allocation Committee (CTCAC) could be another factor to consider. The LIHTC Program started in 1987 and can be claimed annually over a ten-year period “beginning either with the year the building is placed in service or the following year, depending on which option is selected by the owner”.¹⁰⁷ Projects have to remain in compliance for a minimum of 15 years. A more comprehensive analysis could take into consideration these ten-year and 15-year cycles and prioritize complexes that are the closest to their next upgrade cycle.

As mentioned in the section on the input parameters, this study looks at affordable housing with funding from the United States Department of Housing and Urban Development (HUD), the United States Department of Agriculture (USDA), and Low-Income Housing Tax Credit (LIHTC). However, this study does not consider Naturally Occurring Affordable Housing (NOAH), which refers to “existing multifamily rental properties that are

¹⁰³ Common Spark Consulting (2021). *The Flipside Report: A White Paper on Targeted Geographic Electrification in California's Gas Transition*.

¹⁰⁴ PG&E (n.d.). *Current Outages and Future PSPS Outages Map*. <https://pgealerts.alerts.pge.com/outages/map/>

¹⁰⁵ Southern California Edison (n.d.). *Public Safety Power Shutoff - Am I Impacted?*. <https://www.sce.com/wildfire/psps>

¹⁰⁶ San Diego Gas and Electric (n.d.). *Outage Map*. <https://www.sdge.com/residential/customer-service/outage-center/outage-map>

¹⁰⁷ California Tax Credit Allocation Committee (2021). *Compliance Online Reference Manual*.

affordable without public subsidy to low-income households”.¹⁰⁸ NOAH constitutes most of the affordable units in the United States.^{109,110,111} According to The California Housing Partnership, “The risk of displacement and homelessness is particularly high for NOAHs located in neighborhoods with high rental prices or in gentrifying areas where rents are increasing rapidly”.¹¹² Therefore, is it important to track and preserve NOAH developments.¹¹³ Once a database with NOAH developments has been developed, this would be an interesting additional input parameter for a geographically-targeted electrification study.

There could be tensions between adjacent neighborhoods that are assigned different priorities in a geographical electrification program. This will likely need to be addressed on a case-by-case basis, and future steps will need to be taken to protect all communities from additional financial burdens regardless of order of electrification priority.

In conclusion, future frameworks and analyses for geographically-targeted electrification could incorporate additional data to provide a more comprehensive evaluation of the different considerations. When electrification plans are carried out, there should be a close collaboration between representatives of vulnerable communities, public health experts, the utilities, and local government leaders.

Conclusion

In this report, we discuss the importance of multifamily affordable housing and ESJ communities in the transition from natural gas to electricity. We reflect on established frameworks and incentive programs, and we propose a methodology to determine key zones for electrification investments. Our proposed geographically-targeted methodology identifies areas in California that have a combination of characteristics that make them particularly of interest for a just transition from natural gas to electricity, and have benefits to the natural gas infrastructure system at large. We propose to prioritize electrification funding towards communities with a high pollution burden, low-income communities with a high housing burden, and areas that are served by an outer branch of a natural gas distribution pipeline (to facilitate decommissioning of individual branches). In addition, we propose a set of policy mechanisms in support of our geographically-targeted electrification framework. With our framework, we hope to alleviate the financial and pollution burdens of environmental and social justice communities, to ensure an equitable and just transition from natural gas to electricity.

¹⁰⁸ Steve King (2021). *Preserving the Largest and Most At-Risk Supply of Affordable Housing*. McKinsey & Company.

¹⁰⁹ Steve King (2021). *Preserving the Largest and Most At-Risk Supply of Affordable Housing*. McKinsey & Company.

¹¹⁰ NOAH Impact Fund (n.d.). <https://noahimpactfund.com/>

¹¹¹ Haisten Willis (2020). *Preserving Communities, Preventing Displacement*. The Washington Post.

¹¹² California Housing Partnership (2019). *Los Angeles County: Annual Affordable Housing Outcomes Report*.

¹¹³ California Housing Partnership (2019). *Los Angeles County: Annual Affordable Housing Outcomes Report*.

Acknowledgements

We are grateful to Panama Bartholomy (Building Decarbonization Coalition) for his guidance and support throughout this project. We would like to thank Fabiola Lao (Center for Sustainable Energy), Srinidhi Sampath (California Housing Partnership), Sean Armstrong (Redwood Energy), and Michelle Vigen Ralston (Common Spark Consulting) for their valuable input and resources as we developed this report. Finally, we want to thank Professor Steven Weissman for providing us with the opportunity to carry out this project in the context of his graduate class on energy regulation and public policy at the University of California, Berkeley.

References

- Ashmoore, O. & NRDC. (2020). *Policy Pathways to Zero-Emissions Buildings*.
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=233372&DocumentContentId=65887>
- Barnes, A. (2021, March 3). *How the Biden Administration's Environmental Justice Mapping Tool Can Identify and Target Benefits to Disadvantaged Communities*. Legal Planet.
<https://legal-planet.org/2021/03/03/how-the-biden-administrations-environmental-justice-mapping-tool-can-identify-and-target-benefits-to-disadvantaged-communities/>
- Barnes, A., Luh, A., & Gobin, M. (2021, February 4). *Mapping Environmental Justice in the Biden-Harris Administration*. Center for American Progress.
<https://www.americanprogress.org/issues/green/reports/2021/02/04/495397/mapping-environmental-justice-biden-harris-administration/>
- Building Decarbonization Coalition. (n.d.). *Homepage*. <https://www.buildingdecarb.org/>
- CalEPA & OEHHA. (n.d.). *Update to the California Communities Environmental Health Screening Tool*.
<https://oehha.ca.gov/media/downloads/calenviroscreen/report/ces3report.pdf>
- California Department of Community Services and Development. (n.d.). *Programs*.
<https://csd.ca.gov/programs/>
- California Department of Community Services and Development. (2019). *Low-Income Weatherization Program: Program Guidelines*.
<https://www.csd.ca.gov/Shared%20Documents/LIWP-SF-FW-Program-Guidelines-2017-18.pdf>
- California Department of Housing and Community Development. (n.d.). *Income Limits*.
<https://www.hcd.ca.gov/grants-funding/income-limits/index.shtml>
- California Energy Codes and Standards. (n.d.). *Statewide Reach Codes and Standards*.
<https://localenergycodes.com/>
- California Energy Commission. (2020). *The Challenge of Retail Gas in California's Low-Carbon Future*.
<https://ww2.energy.ca.gov/2019publications/CEC-500-2019-055/CEC-500-2019-055-F.pdf>
- California Housing Partnership. (n.d.-a). *About us*. California Housing Partnership. <https://chpc.net/about-us/>
- California Housing Partnership. (n.d.-b). *Affordable Housing Benefits Map*. California Housing Partnership.
<https://chpc.net/benefitsmap/?view=37.847274,-122.27054,13&tract=ab1550&boundary=assembly>

- California Housing Partnership. (2019). *Los Angeles County: Annual Affordable Housing Outcomes Report*. http://chpc.net/wp-content/uploads/2019/06/LA-County-Affordable-Housing-Outcome-Report-V3_with-appendix.pdf
- California Housing Partnership. (2021). *Prioritizing California's Affordable Housing in the Transition Towards Equitable Building Decarbonization*. <https://1p08d91kd0c03rlxhmhtydpr-wpengine.netdna-ssl.com/wp-content/uploads/2021/04/BuildingDecarbonizationSummitAHReport2021.pdf>
- California Office of Environmental Health Hazard Assessment (OEHHA). (n.d.-a). *About CalEnviroScreen*. <https://oehha.ca.gov/calenviroscreen/about-calenviroscreen>
- California Office of Environmental Health Hazard Assessment (OEHHA). (n.d.-b). *CalEnviroScreen Overall Results and Individual Indicator Maps*. <https://oehha.maps.arcgis.com/apps/MapSeries/index.html?appid=8dad35dcd2274285874e60871c404edc>
- California Office of Environmental Health Hazard Assessment (OEHHA). (n.d.-c). *Draft CalEnviroScreen 4.0*. <https://oehha.ca.gov/calenviroscreen/report/draft-calenviroscreen-40>
- California Office of Environmental Health Hazard Assessment (OEHHA). (n.d.-d). *Maps & Data: CalEnviroScreen 3.0 Maps*. <https://oehha.ca.gov/calenviroscreen/maps-data>
- California Public Utility Commission (CPUC). (n.d.-a). *California Solar Initiative*. <https://www.cpuc.ca.gov/general.aspx?id=6043>
- California Public Utility Commission (CPUC). (n.d.-b). *CARE/FERA Program*. <https://www.cpuc.ca.gov/lowincome/rates/>
- California Public Utility Commission (CPUC). (n.d.-c). *Disadvantaged Communities*. <https://www.cpuc.ca.gov/discom/>
- California Public Utility Commission (CPUC). (n.d.-d). *Natural Gas and California*. https://www.cpuc.ca.gov/natural_gas/
- California Public Utility Commission (CPUC). (2019). *Environmental and Social Justice Action Plan*. https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/Infrastructure/DC/Env%20and%20Social%20Justice%20ActionPlan_%202019-02-21.docx.pdf
- California Tax Credit Allocation Committee. (2021). *Compliance Online Reference Manual*. <https://www.treasurer.ca.gov/ctcac/compliance/manual/manual.pdf>
- Common Spark Consulting. (n.d.). *What We Do*. Common Spark Consulting. <https://www.common-spark.com/>
- Common Spark Consulting. (2021). *The Flipside Report: A White Paper on Targeted Geographic Electrification in California's Gas Transition*.
- Daniel Fournier, E., Cudd, R., Federico, F., & Pincetl, S. (2020). Implications of the timing of residential natural gas use for appliance electrification efforts. *Environmental Research Letters*, 15(12), 124008. <https://doi.org/10.1088/1748-9326/aba1c0>
- Dirr, N., Chitnis, S., & Association of Energy Affordability. (2020). *Multifamily Clean Heating Pilot: Summary of*

Project-level Analysis and Findings.

https://cbbf458e-67d0-4a11-9597-023b97b18cc4.filesusr.com/ugd/fbb014_5f394d44c3114359b36abf6afa9c460b.pdf

Environmental Protection Agency (EPA). (n.d.). *Report on the Environment: Indoor Air Quality*. US EPA.
<https://www.epa.gov/report-environment/indoor-air-quality>

Fleischman, L. (2019, February 21). *"How Does Natural Gas Production Contribute to Ozone Pollution?": A Podcast with The Endocrine Disruption Exchange*. Clean Air Task Force.
<https://www.catf.us/2019/02/natural-gas-production-ozone-pollution-podcast/>

Gough, M. (2021, April 27). *California's cities lead the way to a gas-free future*. Sierra Club.
<https://www.sierraclub.org/articles/2021/01/californias-cities-lead-way-gas-free-future>

King, S., Peloquin, S., Riesenber, C., & Woetzel, J. (2021, February 23). Preserving the Largest and Most At-Risk Supply of Affordable Housing. *McKinsey & Company*.
<https://www.mckinsey.com/industries/public-and-social-sector/our-insights/preserving-the-largest-and-most-at-risk-supply-of-affordable-housing#>

Lee, M., & Billimoria, S. (2021, March 29). *Eight benefits of building electrification for households, communities, and climate*. RMI.
<https://rmi.org/eight-benefits-of-building-electrification-for-households-communities-and-climate/>

NOAH Impact Fund. (n.d.). *Homepage*. <https://noahimpactfund.com/>

NRDC, CHPC, Earthjustice, & Sierra Club. (n.d.). *Comments on AB 3232 May 22 2020 Workshop*.
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=233372&DocumentContentId=65887>

Pacific Gas and Electric (PG&E). (n.d.-a). *Company Profile*.
https://www.pge.com/en_US/about-pge/company-information/profile/profile.page

Pacific Gas and Electric (PG&E). (n.d.-b). *Current Outages and Future PSPS Outages Map*.
<https://pgealerts.alerts.pge.com/outages/map/>

Pacific Gas and Electric (PG&E). (n.d.-c). *Explore our Natural Gas Transmission Pipeline Map*.
https://www.pge.com/en_US/safety/how-the-system-works/natural-gas-system-overview/gas-transmission-pipeline/gas-transmission-pipelines.page

RMI. (n.d.-a). *About*. RMI. <https://rmi.org/about/>

RMI. (n.d.-b). *e-Lab Accelerator*. RMI.
<https://rmi.org/our-work/electricity/elab-electricity-innovation-lab/elab-accelerator/>

RMI. (n.d.-c). *eLab Accelerator 2020 Teams: Berkeley Electrification and Natural Gas Decommissioning Pilot*. RMI.
<https://rmi.org/elab-accelerator-2020-teams-berkeley-electrification-and-natural-gas-decommissioning-pilot/>

RMI. (n.d.-d). *e-Lab: Electricity Innovation Lab*. RMI.
<https://rmi.org/our-work/electricity/elab-electricity-innovation-lab/>

San Diego Gas and Electric. (n.d.). *Outage Map*.
<https://www.sdge.com/residential/customer-service/outage-center/outage-map>

- Sierra Club. (2019). *Building Electrification Action Plan for Climate Leaders*.
<https://www.sierraclub.org/sites/www.sierraclub.org/files/Building%20Electrification%20Action%20Plan%20for%20Climate%20Leaders.pdf>
- Southern California Edison. (n.d.). *Public Safety Power Shutoff - Am I Impacted?*
<https://www.sce.com/wildfire/psps>
- Southern California Gas Company (SoCalGas). (n.d.-a). *Company Profile*.
<https://www.socalgas.com/about-us/company-profile>
- Southern California Gas Company (SoCalGas). (n.d.-b). *Gas Transmission Pipeline Interactive Map*.
<https://socalgas.maps.arcgis.com/apps/webappviewer/index.html?id=c85ced1227af4c8aae9b19d677969335>
- Southern California Gas Company (SoCalGas). (2019). *Energy Savings Assistance (ESA) Program: Impact Evaluation Program Years 2015-2017*.
<https://liob.cpuc.ca.gov/wp-content/uploads/sites/14/2020/12/ESA-Program-Impact-Evaluation-Program-Years-2015-2017-042619.pdf>
- The Greenlining Institute. (2019). *Equitable Building Electrification: A Framework for Powering Resilient Communities*.
https://greenlining.org/wp-content/uploads/2019/10/Greenlining_EquitableElectrification_Report_2019_WEB.pdf
- Willis, H. (2020, March 19). Preserving Communities, Preventing Displacement. *The Washington Post*.
https://www.washingtonpost.com/realestate/the-noah-conundrum-maintaining-the-lifeboat-for-affordable-rental-housing/2020/03/18/e3e18aa6-12ba-11ea-bf62-eadd5d11f559_story.html
- World Green Building Council. (n.d.). *Climate champion California joins the Net Zero Carbon Buildings Commitment*. World Green Building Council.
<https://www.worldgbc.org/news-media/climate-champion-california-joins-net-zero-carbon-buildings-commitment>